



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
1201 NE Lloyd Boulevard, Suite 1100
PORTLAND, OREGON 97232

Refer to NMFS Consultation No.:
WCRO-2018-00106

June 28, 2019

Aaron Dorf, Colonel
U.S. Army Corps of Engineers (Corps), Portland District
Post Office Box 2946
Portland, Oregon 97208-2946

Re: Final Biological Opinion on the Willamette Basin Review Feasibility Study, Willamette River Basin, Oregon.

Dear Colonel Dorf:

Thank you for your September 14, 2018, letter and biological assessment requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act (ESA) of 1973 (16 U.S.C. 1531 et seq.) for the Corps' proposed Willamette Basin Review Feasibility Study in the Willamette Valley, Oregon.

NMFS' final biological opinion pursuant to ESA section 7(a)(2) on the effects of the Willamette Basin Review Feasibility Study is enclosed with this letter. We shared a draft opinion with the Corps on March 28, 2019. In our final opinion, we conclude that the proposed action is likely to jeopardize the continued existence of ESA-listed Upper Willamette River Chinook salmon and Upper Willamette River steelhead. We also conclude that the proposed action is likely to result in the adverse modification of critical habitat for these species. Our opinion includes a Reasonable and Prudent Alternative to the proposed action that, if implemented by the Corps, will offset the effects of the proposed action such that the effects are not likely to jeopardize Upper Willamette River Chinook salmon and Upper Willamette River steelhead or adversely modify their designated critical habitat.

We further conclude that the proposed action is not likely to jeopardize the continued existence of Lower Columbia River Chinook salmon, Upper Columbia River spring-run Chinook salmon, Snake River spring/summer run Chinook salmon, Snake River fall-run Chinook salmon, Columbia River chum salmon, Lower Columbia River coho salmon, Snake River sockeye salmon, Lower Columbia River steelhead, Middle Columbia River steelhead, Upper Columbia River steelhead, or Snake River Basin steelhead, or to destroy or adversely modify their critical habitat. Additionally, we conclude the proposed action is not likely to adversely affect Southern Resident killer whales or their critical habitat.

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We also evaluated potential impacts of the action on essential fish habitat (EFH) in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 et seq.) and implementing regulations at 50 CFR 600. We conclude that the proposed action would adversely affect EFH designated for Pacific Coast Salmon.

Please send comments to Marc Liverman, the Willamette Branch Chief in our Portland office, at marc.liverman@noaa.gov. He is also available at 503-231-2336 if you have any questions or would like additional information regarding this consultation.

Sincerely,



Barry A. Thom
Regional Administrator

cc: Amy C. Gibbons, Corps of Engineers, Environmental Resources Branch
Richard Piaskowski, Corps of Engineers
Jesse Granet, Corps of Engineers

**Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens
Fishery Conservation and Management Act Essential Fish Habitat Response for the**

Willamette Basin Review Feasibility Study

NMFS Consultation Number: WCRO-2018-00106

Action Agency: United States Army Corps of Engineers, Portland District


Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Upper Willamette River Chinook salmon	T	Yes	Yes	Yes	Yes
Upper Willamette River steelhead	T	Yes	Yes	Yes	Yes
Lower Columbia River Chinook salmon	T	Yes	No	Yes	No
Upper Columbia River spring-run Chinook salmon	E	Yes	No	Yes	No
Snake River spring/summer run Chinook salmon	T	Yes	No	Yes	No
Snake River fall-run Chinook salmon	T	Yes	No	Yes	No
Columbia River chum salmon	T	Yes	No	Yes	No
Lower Columbia River coho salmon	T	Yes	No	Yes	No
Snake River sockeye salmon	E	Yes	No	Yes	No
Lower Columbia River steelhead	T	Yes	No	Yes	No
Middle Columbia River steelhead	T	Yes	No	Yes	No
Upper Columbia River steelhead	T	Yes	No	Yes	No
Snake River Basin steelhead	T	Yes	No	Yes	No
Southern Resident killer whale (<i>Orcinus orca</i>)	E	No	No	No	No

Fishery Management Plan That Identifies EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	Yes	Yes

Consultation Conducted By: National Marine Fisheries Service, West Coast Region

Issued By:


 Barry A. Thom
 Regional Administrator

Date: June 28, 2019

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1. INTRODUCTION

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into Sections 2 and 3, below.

1.1 Background

The National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 USC 1531 et seq.), and implementing regulations at 50 CFR 402. We also completed an essential fish habitat (EFH) consultation on the proposed action, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 et seq.) and implementing regulations at 50 CFR 600.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). A complete record of this consultation is on file at the Oregon Washington Coastal Office in Portland, Oregon.

1.1.1 The Willamette Valley Project & 2008 NMFS Biological Opinion

Operated by the Portland District, United States Army Corps of Engineers (USACE), the Willamette Valley Project, also known as the Willamette Valley System (WVS) is a series of 13 major dams and associated infrastructure in the Willamette Basin in Oregon. Operation and maintenance of the WVS provides flood risk reduction, hydropower generation, water for irrigation, minimum flows (originally for navigation, now relied on for water quality), and provides benefits for other authorized project purposes including water quality, recreation, and fisheries conservation. Prior ESA consultation with NMFS resulted in a 2008 Biological Opinion (BiOp) which concluded that the operation and maintenance of the WVS would jeopardize the continued existence of threatened UWR Chinook salmon and steelhead and adversely modify their critical habitat. NMFS additionally concluded continued operation of the WVS would adversely affect but not jeopardize an additional 11 species of Interior and Lower Columbia Basin salmon and steelhead, nor would it destroy or adversely modify the critical habitats designated for those species. Adverse effects of the WVS on ESA-listed species included restricting access to upstream habitats, and degrading water quality and available habitat below the dams. The 2008 BiOp provided a Reasonable and Prudent Alternative (RPA) which included several measures that, when followed, would reduce these effects sufficiently to avoid jeopardizing UWR Chinook and UWR steelhead by allowing them to survive with an adequate potential for recovery (NMFS 2008a). These measures included actions such as coordination among agencies and resource managers, structural fish passage improvements, operations to improve water quality, habitat improvements, hatchery programs, water contracting, and research. This RPA is currently being implemented, and the status of various measures is described in further detail in the Environmental Baseline (Section 2.4).

The WVS serves several functions related to the storage and release of water in the Willamette Basin. Under current configurations and operations the system of 13 reservoirs can store approximately 1,590,000 acre-feet of water for release during the summer and early fall to benefit water quality, hydropower, irrigation, municipal and industrial (M&I) water supply, flow augmentation for pollution abatement and improved fishery conditions, and recreation.

Approximately 75,000 acre-feet of stored water is currently contracted through the U.S. Bureau of Reclamation (Reclamation) for agricultural use (USACE, 2017). The 2008 BiOp RPA currently limits the water contracting program to a total of 95,000 acre-feet, although consultation has been reinitiated on operation and maintenance of the WVS so it is not known what future limits may exist. The remainder of the stored water is currently considered “joint use” and released for multiple project purposes by the U.S Army Corps of Engineers (Corps) with input from a multi-agency flow and water quality management technical team.

The 2008 BiOp RPA also contains targets for instream flows released from the WVS dams for the benefit of ESA-listed fish. Minimum and maximum targets exist for tributaries where the dams are located and in the mainstem Willamette River near the cities of Albany and Salem. These flow targets are also currently under review and subject to change in the future as a result of new information, as provided for by the 2008 BiOp RPA. Releases of water from the WVS are also managed under RPA measures intended to reduce water quality impacts of the dams, specifically from temperature and dissolved gases. In addition, the RPA contains a measure to ensure stored water released for instream beneficial uses could be protected downstream with additional water rights.

The proposed action is to reallocate the water storage space contained in the 13 WVS reservoirs to allow for new use types and water marketing programs, as described in more detail in the proposed action (Section 1.3). This would result in changes to current operations for the storage and release of water from behind WVS dams, which could affect these RPA measures, as discussed further in Section 2.5.

1.2 Consultation History

The Willamette Basin Review (WBR) Feasibility Study (FS) began in 1996 to investigate future water demand in the basin with respect to the operation of the WVS during the summer conservation storage and flow release season. In March 1999, Upper Willamette River (UWR) steelhead and UWR Chinook salmon were listed as threatened species under the ESA (64 FR 14308, 64 FR 14517). In April 1999, the WBR FS was suspended pending formal consultation on the continued operation of the WVS as required under Section 7 of the ESA.

Formal consultation on the operation of the WVS began in April 2000 between the action agencies (i.e., the Corps, Bureau of Reclamation (BOR), and Bonneville Power Administration (BPA) and NMFS and USFWS. This process ultimately resulted in a final 2008 NMFS BiOp which determined that continued operation of the WVS would jeopardize the continued existence of UWR Chinook salmon and UWR steelhead, and destroy or adversely modify their critical habitats. As a result of these findings, NMFS provided the action agencies with an RPA to allow for the WVS to continue operating consistent with its purpose and need and allow for the

survival of UWR Chinook and UWR steelhead with an adequate potential for recovery, as described above in Section 1.1.

Work on the WBR feasibility study resumed in August 2015 with the goal of reallocating WVS conservation storage for the benefit of fish and wildlife (F&W), agricultural irrigation (AI), and municipal and industrial (M&I) water supply over a 50-year period of analysis, while continuing to fulfill other project purposes. The non-federal sponsor for the feasibility study is the Oregon Water Resources Department (OWRD). The feasibility study will result in a Chief of Engineer's approval report verifying project recommendations, which is proposed to be incorporated into legislation, in the form of a Water Resources Development Act (WRDA) bill, to be considered for passage by Congress, which if passed would allow for the change in allocated amounts of stored water for previously authorized purposes.

During 2016 and 2017, public meetings were held, working groups were convened, and analyses were completed to develop a draft integrated Feasibility Report and Environmental Assessment (FR/EA) which the Corps released November 7, 2017. This 2017 draft FR/EA described a tentatively selected plan (TSP) for allocation and management of WVS stored water. NMFS responded in December 2017 during the public comment period with initial questions and recommendations for additional analyses for the Corps to consider in refining and selecting their alternatives for WBR. In response to input received during the public comment period and a letter from Oregon state agencies (including the study sponsor, OWRD) received by the Corps in May 2018, the Corps decided to put forward a revised allocation and management scheme as their Agency Recommended Plan (ARP), which is the proposed action for this consultation. Details of the ARP/proposed action are described in Section 1.3.

Since that time, ESA consultation on the proposed action has proceeded with NMFS along the following timeline:

- On July 2, 2018, NMFS received request from the Corps and a supporting biological assessment (BA) asking NMFS to concur with the Corps' finding that the proposed action is "Not Likely to Adversely Affect" (NLAA) ESA-listed species or designated critical habitats.
- On July 27, 2018, NMFS replied that it did not concur with the Corps' "Not Likely to Adversely Affect" finding, citing information in the BA that the proposed action would have adverse effects on the Corps' ability to meet flow targets described in the Reasonable and Prudent Alternative (RPA) issued with the 2008 BiOp. As noted above, that BiOp concluded that operation and maintenance of the WVS would jeopardize the continued existence of UWR Chinook salmon and steelhead and adversely modify their critical habitat.
- On September 14, 2018, the Corps asked to initiate formal consultation with NMFS regarding the effects of the WBR using information in the same BA provided on July 2, 2018.
- On October 15, 2018, NMFS confirmed that consultation was initiated on September 14, 2018, and requested additional information regarding the scope of the action, and the analyses and assumptions presented in the BA.

- On November 9-14, 2018, the Corps responded by providing additional information and supplemental data files, including updated analyses from the revised draft FR/EA.
- On November 20, 2018, NMFS again requested additional information.
- On December 12, 2018, NMFS and the Corps met with representatives from OWRD and ODFW to discuss the role of the state in implementing the water management strategy in the proposed action.
- From December 22, 2018, through January 25, 2019, NMFS was required to execute a “shutdown” with a furlough of NMFS staff due to a lapse in appropriations.
- On January 28, 2019, the Corps responded to NMFS request for additional information in response to questions that arose during December 12, 2018 meeting.
- On March 26, 2019, NMFS issued a Preliminary Draft Opinion for review by the Corps with a finding that the proposed action would jeopardize the continued existence of UWR Chinook salmon and steelhead and adversely modify their critical habitat.
- Between March 26 and June 11, 2019, NMFS and the Corps had a number of meetings to discuss the draft opinion and refine the Reasonable and Prudent Alternative.
- On June 28, 2019, NMFS issued a final Opinion.

1.2.1 Consultation with Affected Indian Tribes

Secretarial Order No. 3206 on American Indian Tribal Rights, Federal-Tribal Trust Responsibilities, and Endangered Species Act (SO) (June 5, 1997) identifies responsibilities of the Departments of Commerce and the Interior when actions or regulations under the ESA may affect Indian lands, tribal trust resources, or the exercise of American Indian tribal rights, as follows:

The Departments will carry out their responsibilities under the Act in a manner that harmonizes the federal trust responsibilities to tribes, tribal sovereignty, and statutory missions of the Departments.” Specifically, NMFS is directed to solicit relevant information from the tribes should they wish to offer any, and to encourage Action Agencies to include affected Tribes in their consultation process.

By letters to tribal council leaders sent between November 30 and December 6, 2018, NMFS notified the following tribes and tribal associations which may potentially have an interest in the Proposed Action of its ESA consultation regarding the Willamette Basin Review:

- Columbia River Inter-Tribal Fish Commission (CRITFC)
- Confederated Tribes of the Warm Springs Reservation (CTWS)
- Confederated Tribes and Bands of the Yakama Nation (Yakama)
- Confederated Tribes of the Grand Ronde Community of Oregon (CTGR)
- Confederated Tribes of Siletz Indians of Oregon (CTSI)
- Burns Paiute Tribe
- Coeur D’Alene Tribe
- Confederated Tribes of the Colville Reservation
- Confederated Salish & Kootenai Tribes
- Confederated Tribes of the Umatilla Indian Reservation (CTUIR)

- Cowlitz Indian Tribe
- Kalispel Tribe
- Kootenai Tribe of Idaho
- Nez Perce Indian Tribe
- Shoshone-Bannock Tribes
- Shoshone-Paiute Tribe
- Spokane Tribe of Indians
- Upper Columbia United Tribes (UCUT)
- Upper Snake River Tribes Foundation

Copies of these letters were also sent to designated contact personnel in their respective tribe's natural resources or fisheries programs. The letters summarized the purpose of this consultation and solicited information, traditional knowledge, or comments the tribes and associations might provide to help in the consultation.

Subsequently, NMFS staff contacted designated personnel at each tribe and association known to have been active in recent consultations in the Willamette Basin, known to have participated in the WVS 2008 BiOp consultation, or implementation, or who responded to the notification letter with interest in providing input on this consultation. Those tribes and associations included the CRITFC, CTWS, Yakama, CTGR, CTSI, and CTUIR. All groups confirmed they had received NMFS' notification letter, and were invited to participate in discussions to seek the tribes' perspective on potential effects of the proposed action on any Tribal resources and rights, or to provide written feedback to that effect. Between December 6, 2018 and February 11, 2019 NMFS staff contacted designated personnel via phone messages and email to solicit input on this consultation.

Tribal biologists, policy analysts, and attorneys from the CTUIR, CTGR, and CRITFC participated in phone meetings with NMFS on February 21, March 1, and May 28, 2019, respectively. Tribal representatives were invited to ask questions and provide information and verbal comments.

Initial verbal comments from meetings with CTUIR and CTGR included concerns from tribal representatives that instream flows for fish were not being prioritized over other uses, as both fish and water are considered critical First Food tribal resources. Representatives also expressed concern over the uncertainty of whether and how instream flow protections for fish and wildlife would be implemented. Some representatives expressed their view that ESA compliance should be required to be met before other uses can be allowed to have access to WVS stored water. Others shared that their view that the 1855 Willamette Valley Treaty entitles the tribes to fish runs and habitat conditions as they existed in 1855, however, historically these resources have been treated as an afterthought to dam construction and operation. This consultation raises concerns for tribal representatives that salmon and steelhead would again not receive adequate consideration in the event of future water shortages.

Specific to implementation of the 2008 WVS BiOp, tribal representatives also expressed concern that the WBR proposed action would prematurely allocate water and eliminate fish passage options from future consideration. They noted there is still limited information on alternative

operations for passage at WVS dams and how juvenile fish collectors currently in design will perform, so there is a need to retain flexibility. Representatives stated that they would like to see the parties hold off on allocation of the WVS stored water until passage is dealt with so all current options remain available.

Tribal representatives stressed to NMFS the importance of other resident fish species and aquatic species, such as freshwater mussels, which may be affected by this action but are not currently listed under the ESA. Tribes also expressed interest in the WBR consultation specifically as it might affect Pacific lamprey (*Lampetra tridentata*) in the Willamette Basin. There has been considerable investment in downstream restoration for the benefit of lamprey, and representatives were concerned that the proposed action could undermine the benefits of those actions depending on the extent flows and water quality were impacted.

NMFS also indicated that it would propose consideration of lamprey protection and tribal participation in studies and other measures in its recommended conservation measures.

Representatives from CRITFC later replied with the following specific written comments on June 13, 2019 (transmitted via email):

To the best of our knowledge, there was no tribal consultation regarding the 2019 BiOp or the Feasibility Study and Environmental Assessment. While there was written outreach and some communication with tribal staff, these preliminary steps do not constitute consultation, given the important resource allocation decisions at stake. The Willamette River Basin Reallocation Project was briefly explained to CRITFC staff, however this briefing only occurred after the opportunity for comment and input on the project had passed. Consultation is not simply explaining the federal government's chosen path forward, rather it is a process of reaching agreement in the decision making process itself, including sharing meaningful information in a timely fashion. Additionally, it is difficult to consult on the tribal concerns surrounding a BiOp or Environmental Assessment that the tribes are unable to view. Secretarial Order 3206 provides that:

Whenever the agencies, bureaus, and offices of the Departments are aware that their actions planned under the Act may impact tribal trust resources, the exercise of tribal rights, or Indian lands, they shall consult with, and seek the participation of, the affected Indian tribes to the maximum extent practicable. This shall include providing affected tribes adequate opportunities to participate in data collection, consensus seeking, and associated processes. To facilitate the government-to-government relationship, the Departments may coordinate their discussions with a representative from an intertribal organization, if so designated by the affected tribe(s).

Principle 1, Secretarial Order 3206. American Indian Tribal Rights, Federal-Tribal Trust Responsibilities, and the Endangered Species Act.

We have multiple large concerns outlined briefly below, but if there was time allotted for a thorough consultation, they would be explored more in depth by all those occupying seats at the table:

One of our greatest concerns is the impact the project will have on the Pacific lamprey in the Willamette Valley. Lamprey are as vital to tribal subsistence as salmon, and provide an important source of food for the tribes in the basin. The Commission's member tribes have harvested lamprey at Willamette Falls for millennia. Some of the work CRITFC and its member tribes have conducted to conserve Willamette Basin lamprey populations can be found in The Tribal Pacific Lamprey Restoration Plan for the Columbia River Basin. https://critfc.org/wp-content/uploads/2012/12/lamprey_plan.pdf. The Willamette River basin is one of the most prominent habitats for lamprey, with Willamette Falls as a significant historical fishing site. Additionally, within the basin, the largest proportion of lamprey in the Willamette Basin inhabit the Santiam River, a tributary that will be affected by this project. Diminished in the Columbia River, the Willamette is one of the last few basins for lamprey to thrive. It's also important to add that there has been a number of restoration projects done for the lamprey in the basin and without enough flow they may be all for not. Yet, there is no discussion of the effects of the project on lamprey in the USACE's EA or its appendices. In fact, the word "lamprey" does not even appear in these documents.

There is ample information that could have been considered about lamprey populations in USACE's study effort. Chapter 13 of the USFWS' Lamprey Assessment is dedicated to lamprey populations in the Willamette Valley states:

Water diversions and impoundments alter the quantity and timing of flow events, which may impact adult and juvenile lamprey migration cues, decrease spawning habitat availability, prevent access to backwater or side channel habitats, create low water barriers, and contribute to mortality if incubating eggs or burrowing larvae are dewatered or exposed to a high temperature or low oxygen environment (Clemens et al. 2017b). Some improvements to flow regimes have occurred in the Willamette Basin. https://www.fws.gov/pacificlamprey/Documents/PacificLamprey_2018Assessment_final_02282019.pdf at page 165.

Another concern is how the change in water allocation will affect water quality in the Willamette River Basin. Will the shift in flows as a result of new water rights negatively affect the water quality in the basin? The quality of water disproportionately impacts juvenile lamprey, who spend up to seven years filter feeding in the silt and gravel of stream beds, making them particularly susceptible to toxics that settle in and out of the water. ESA-listed steelhead and Chinook salmon are also vulnerable to water quality degradation and rely on flow objectives to dilute concentrations of toxics from municipalities, industry, and agricultural runoff. Increased flows also help maintain cooler temperatures and

increase beneficial dissolved oxygen. How will the changes to the flows in the system affect these processes?

Climate change was not thoroughly taken into consideration in the Willamette River Basin EA, and may not be taken into consideration in the 2019 BiOp. The EA did not acknowledge the possibility that there may be an increase in years in which the basin does not fully fill due to climate change. This should of been considered when determining the proportionate reduction of water from allocation areas in years where the basin does not fully fill. For example, a more snowpack driven tributary, like the North Santiam, may be affected by climate change differently than rain driven tributaries, and may require a different drought plan for the fish and wildlife in that river. Additionally, climate change will affect the local flows that are relied upon in the data to meet the BiOp objectives. Not factoring in climate change may overestimate the amount of water those local flows are able to contribute to BiOp flow objectives. Climate change will also affect the timing of flows into the system and that should be taken into consideration. The temperature of the water will also be affected by climate change and steelhead and Chinook salmon may require more water rights to keep Willamette tributaries at a habitable temperature. Overall, the inevitability of climate change was not factored into this project by the USACE.

The USACE allocated water storage based on peak demands but assessed the project's environmental impacts based on expected use. This may not accurately reflect the impacts the new allocated water rights will have on the system.

Perhaps the greatest concern is that there is not enough water allocated to fish and wildlife. The models show that BiOp flow requirements are not consistently met, and in years of deficit and insufficient water availability, they are missed significantly. Meeting the BiOp objectives is necessary to protect ESA-listed steelhead and Chinook salmon. Additionally, the models show that the no action alternative is better for meeting the BiOp flow objectives in deficit and insufficient years, especially at tributaries like the Santiam where there are vital lamprey populations. Fish and wildlife will need more instream flows to combat the changing climate and decreasing flows in their river.

We believe that an Environmental Impact Statement is needed to better understand the impacts of this action and that more planning on the state level is needed before the federal approval of this action. The unknowns of how enforcement will work, when and where the water will be drawn from, distribution of the drought plan, and distribution of instream flows is unclear. Also, there is the major uncertainty of how the implementation of instream flow protections for fish and wildlife will work. An EIS would present the opportunity to address the mitigation needs for lamprey. At minimum, since the current plan calls for many annually made decisions, CRITFC would like to see effective and frequent tribal consultation surrounding those decisions.

CRITFC would like to reemphasize that we do not view the efforts made here as effective tribal consultation.

1.3 Proposed Federal Action

“Action” means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02). Federal action means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal Agency (50 CFR 600.910). “Interrelated actions” are those that are part of a larger action and depend on the larger action for their justification. “Interdependent actions” are those that have no independent utility apart from the action under consideration (50 CFR 402.02).

The Corps is proposing to reallocate storage space in the Willamette Basin reservoirs to establish specific storage volumes to meet the projected future water supply needs of agricultural irrigation (AI), municipal and industrial (M&I) users, and fish and wildlife (F&W), while fulfilling other project purposes. The Corps is further proposing to initiate a water marketing program, upon completion of the reallocation, to issue water storage contracts to M&I users, and guidelines for managing stored water releases according to a system of “proportionate reduction” when the conservation pool does not fill.

This proposed action contains many components and steps which must be completed for all of the intended outcomes to occur, including achievement of flow targets established for ESA-listed salmon and steelhead, and protection stored water allocated for F&W use as instream flow. Some would be undertaken by the Corps and others require actions by state and federal agencies or Congress. These actions are part of the Agency Recommended Plan (ARP) and depend on the ARP for their justification, and are therefore interrelated effects of the proposed action.

1.3.1 Feasibility Report/Environmental Assessment Recommendations

As part of the Feasibility Report/Environmental Assessment (FR/EA) for this action, the Corps investigated future water demand in the Willamette Basin over a 50-year period of analysis with respect to the operation of the WVS system of dams and reservoirs. Based on that analysis, the Corps is proposing the ARP with recommendations for the reallocation of the reservoir storage space available to fill and release water during the summer conservation season for project purposes other than flood control. Reallocation would assign specific maximum storage volumes for AI, M&I, and F&W uses for the entire system of 13 reservoirs managed by the Corps in the Willamette Basin. The Corps is also recommending in-season management strategies to reduce available water among all uses when the total volume stored prior to the conservation season less than the maximum available for a given year.

Proposed Re-Allocation Recommendations

Reservoirs in the WVS are allocated as “joint-use” water which can be released for multiple project purposes, although BOR holds those storage certificates and can currently only issue contracts for stored water for irrigated agriculture. The Corps is proposing to reallocate 1,590,000 acre-feet of total storage space across all 13 reservoirs in the WVS. This volume is

known as the conservation pool storage, and represents the total possible volume in the reservoirs when allowed to fill with water as flood risk diminishes in the spring, which is released through the summer and fall in order to meet downstream uses and to drain the reservoirs before the onset of the next flood season. Water is currently released during the conservation season to meet existing Bureau of Reclamation (BOR) agricultural contracts, the minimum flow targets required by the NMFS 2008 BiOp and RPA, and mainstem targets established for navigation now relied on to meet water quality needs downstream of WVS dams (NMFS 2008a).

The available storage space of 1,590,000 acre-feet (or 1.59 million acre-feet, MAF) is the sum of storage available at each reservoir. Storage space available in each reservoir is calculated based on the volume between a maximum elevation determined by flood risk and safety constraints (i.e., “maximum conservation pool”), and a minimum elevation required for a project to retain the ability to generate power or based on physical limitations of the dam outlets. The 1.59 MAF is considered the total conservation storage capacity for the system, which would only be available when the system fills completely. This capacity does not include storage space that is above maximum conservation pool or storage reserved for power generation, and does not consider structural changes or changes to flood risk management rule curves for refill and discharge of the reservoirs which would add storage at existing dams.

The Corps is proposing to reallocate the 1.59 MAF of WVS conservation storage as follows:

Category	Allocation (acre-feet)	Percent of Total Storage Available
F&W	1,102,600	69%
M&I	159,750	10%
AI	327,650	21%

The Corps has stated that how these volumes are distributed among reservoirs is yet to be determined, and would likely be decided as part of an annual water management process. Similarly, there is no fixed schedule for the release of stored water over the April through October conservation season. Each user holding a contract for stored water is expected to determine the schedule for release of their water over the conservation season on an annual basis.

Until under contract stored water allocated for AI and M&I would be considered joint-use, and could be used for other authorized purposes. All water allocated for F&W would be treated as under contract immediately, and would not be available for joint-use at any point. The release timing of joint-use water to achieve multiple authorized project purposes during the conservation season would be determined by the existing interagency Flow Management Water Quality Team (FMWQT) which currently coordinates in-season management of conservation storage under the Biological Opinion for operation of the WVS (NMFS 2008a). The Corps also proposes to continue developing an Annual Conservation Plan and coordinating with other federal and state agencies to implement their revised Drought Contingency Plan (USACE 2018a).

Guidelines for managing stored water release when the conservation pool does not fill

The ARP also makes recommendations about how the amount of stored water available to the allocated uses will be reduced when the total available storage capacity does not fill in a given year. In years where the system does not refill to 1.59 MAF, the Corps proposes that users' available water would be reduced in proportion to the volume of conservation storage available. Under this plan the F&W allocation, M&I storage under contract, and AI storage under contract would be reduced so that each use category would receive the same percentage of the limited conservation storage water as they would have if the full WVS conservation storage capacity was available (USACE 2018b, USACE 2019a). Each year, users would be notified in April of estimated stored water availability for the year based on forecasts, and final system storage and commensurate stored water available for each use would be determined in June (USACE 2018a). It has not yet been determined how individual M&I and AI contract holders would be reduced or "regulated-off" by OWRD so that each use type would be proportionately reduced when the system does not fill.

1.3.2 Actions by Other Agencies or Federal Entities

To complete the WBR, the Corps must draft a Chief's Report containing recommendations on reallocation and management of the WVS system conservation storage and subsequent water marketing program, and to submit the report for congressional authorization. The proposed action assumes (based on discussions with the agencies involved) that once the action agency submits the Chief's Report to Congress, the Bureau of Reclamation (BOR), OWRD, and Oregon Department of Fish and Wildlife (ODFW) will take additional steps to complete the reallocation process. The following actions are beyond the Corps' authority, but would need to be taken to execute intended changes to the character of use of existing WVS reservoir storage certificates.

- Congress would need to pass legislation to authorize changes to the allowed uses of stored water in WVS reservoirs from "joint use" consistent with volumes specified for different use types in the ARP.
- BOR would file a transfer application to change the character of use for current WVS storage water right certificates, consistent with the recommendations in the ARP.
- OWRD would, after completing a public review process, issue an approval order for the change in character of use of WVS storage certificates consistent with the ARP.
- New reservoir storage agreements would be created between BOR and AI users, the Corps and M&I users, and the Corps and ODFW for F&W instream use.
- Holders of new storage agreements (i.e., ODFW, AI users, and M&I users) would apply for secondary water rights from OWRD, which would grant these rights to allow stored water released from the dams to be protected downstream to the point of diversion.
- OWRD will monitor withdrawals that may affect these secondary water rights, and if needed, notify junior users to stop diverting live flows, known as 'regulating off,' to protect senior water rights.

New storage agreements and secondary water rights will continue to be issued for AI and M&I users through this process as demand for stored water materializes, within existing regulatory constraints, until the contracted amounts reach the allocated volumes for each use type.

2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, each Federal agency must ensure that its actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provides an opinion stating how the agency's actions would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

Our analysis determined the proposed action is not likely to adversely affect Southern Resident Killer Whales. This is documented in the "Not Likely to Adversely Affect" Determinations section (2.12).

2.1 Analytical Approach

This biological opinion includes both a jeopardy analysis and/or an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of" a listed species, which is "to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This biological opinion relies on the definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features" (81 FR 7214).

The designation(s) of critical habitat for (species) use(s) the term primary constituent element (PCE) or essential features. The new critical habitat regulations (81 FR 7414) replace this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

We use the following approach to determine whether a proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Identify the rangewide status of the species and critical habitat expected to be adversely affected by the proposed action.

- Describe the environmental baseline in the action area.
- Analyze the effects of the proposed action on both species and their habitat using an “exposure-response-risk” approach.
- Describe any cumulative effects in the action area.
- Integrate and synthesize the above factors by: (1) Reviewing the status of the species and critical habitat; and (2) adding the effects of the action, the environmental baseline, and cumulative effects to assess the risk that the proposed action poses to species and critical habitat.
- Reach a conclusion about whether species are jeopardized or critical habitat is adversely modified.
- If necessary, suggest a RPA to the proposed action.

2.1.1 Certainty & Assumptions

Analyzing the effects of the proposed action on listed species and critical habitat requires us to make assumptions about the likelihood of future events occurring, and the nature and extent of those future indirect effects. We approached this analysis by first characterizing the likelihood of potential indirect effects. Once we determined those effects reasonably certain to occur, we estimated the magnitude and duration of the indirect effects with the best available information and, when available information was insufficient, made conservative assumptions that were least likely to underestimate potential harm to the species.

The proposed action relies on future actions by other agencies and federal entities for the intended effects of WBR to be realized. The certainty of implementation of those future action varies as described in the BA (USACE 2018a). Until those future actions are completed, the proposed allocation or aspects of it would be rendered ineffective; for example, if OWRD is not able to issue the change in character of use for the reservoir storage certificates then no subsequent contracts for storage space or secondary water rights for stored water may be issued for M&I or F&W. To assess the uncertainty of future actions by non-action agency parties we referred to the standard used in listing decisions for determining whether a proposed conservation effort is sufficiently certain to occur (68 FR 15100) as general guidance for what to include in our evaluation. Under this policy, several criteria are applied to proposed actions to evaluate the likelihood they will be implemented and the likelihood they will be effective. For the purposes of this analysis, we apply that same standard to determine how likely a step is to occur, and how likely it is to be implemented as assumed in the information provided by the action agency (i.e., in their Biological Assessment and supplemental information provided by the Corps from July 2019 through January 2019). Where this involves substantially unknown or unknowable information, NMFS makes conservative assumptions which give the benefit of doubt to listed species.

2.1.2 Allocation Changes to Storage Certificates

Congressional Action

The proposed action assumes a Water Resources Development Act (WRDA) bill would be passed by Congress to uphold the specific recommendations in the Chief’s Report, consistent

with the ARP. This assumption is consistent with prior bills authorizing WVS uses “substantially in accordance” with a Chief’s Report (e.g., the 1950 Flood Control Act authorizing the WVS). Although it is possible that the resulting WRDA bill would differ from the Chief’s Report, the specific legal procedural requirements are well known and this regulatory mechanism is in place with a history of successful similar actions. The anticipated timing of this legislation is not known but WRDA bills are scheduled to be put before Congress every two years (the most recent was in 2018) so this step is sufficiently certain to occur as anticipated in the BA for NMFS to include this assumption in our analysis.

Bureau of Reclamation

The BOR holds the storage water rights certificates for the WVS conservation storage on behalf of the Corps. The character of use on the storage certificate currently only allows for AI storage contracts, which are issued by BOR. BOR needs to request a change to the character of use to allow for storage contracts for non-irrigation use categories. The proposed action assumes BOR will file a transfer application to change the character of use for current WVS storage water right certificates, consistent with the recommendations in the ARP. BOR has indicated to the Corps that they would prefer for the change to match the allocation (USACE 2018c), although there is no legal requirement to complete the allocation process prior to BOR requesting such a change. Given the agreement of BOR and the known legal mechanism this request is sufficiently certain to occur consistent with the ARP for NMFS to include this assumption in our analysis.

Oregon Water Resources Department

Upon receiving a transfer application, OWRD would review it to determine whether the proposed change in character of use would injure other water rights. In addition, OWRD would conduct a public review process where protests could be filed to potentially challenge OWRD’s determination. The proposed action assumes that OWRD would grant the change in character of use for the WVS storage water right certificates, consistent with the ARP and without conditions that would impede the users from obtaining water rights for stored water as described in the ARP. However, it is currently the position of the State of Oregon that OWRD does not have the authority to issue changes in the character of use for reservoir storage certificates, although OWRD and other agencies are pursuing a legislative action to address that limitation (Woodcock and McCord 2018). Also, based on similar actions that have been pursued in Oregon, it is likely that other water rights holders would claim injury and file protests to challenge approval from OWRD (Woodcock and McCord 2018). Specifically, it is likely that potential users of AI water would contest allocations for M&I and F&W because current limitations on storage certificates only allow for WVS storage water to be contracted for AI; allocating for new use types is likely to be characterized by potential opponents to the designation as a reduction in water currently available to AI (Perkowski 2017).

The proposed agreement to provide ODFW with a portion of the storage volume for Minimum Perennial Streamflows (MPSFs) states that stored water rights for MPSFs would carry the date they were adopted as the priority date (ORS 537.346), many of which are concurrent with completion of WVS dam construction from 1964-1966. Therefore, a change to the character of use facilitating the protection of the stored water component of MPSFs would not be considered

injury to water rights with later priority dates. However, it is not clear if additional water storage allocated for F&W to meet current 2008 BiOp RPA flow targets, or for storage allocated to M&I uses, would be found to potentially injure other state water right holders. OWRD may condition any approval order to eliminate potential injury to other water rights. If injury to other water rights could not be eliminated with conditions on the new water storage rights, the transfer application would be denied.

While the legal procedures and regulatory processes for this step are known, not all proposed users of storage water are in agreement about the allocation volumes and the OWRD does not have authority to issue transfers that would potentially injure other users' rights. Therefore, it is not sufficiently certain that the transfer would be issued consistent with the ARP allocation for F&W for NMFS to include this assumption in our analysis. It is also possible that as a result of these processes the transfer issued would be inconsistent with the ARP allocation volume proposed for M&I. In the absence of certainty, NMFS must rely on conservative assumptions to assure that uncertainty is resolved in a manner that does not result in harm to species. Therefore, an appropriately conservative assumption regarding the potential effects of this action is that the transfer would be issued with a change in the character of use consistent with the full allocation volume proposed for M&I, while assuming that the volume requested for F&W may be reduced or denied.

2.1.3 Storage Agreements

BOR Contracts for AI

The BOR is expected to continue issuing new contracts to AI users for the use of WVS conservation storage as they have under the existing BiOp for the WVS (NMFS 2008a). Mechanisms currently exist for these contracts to be issued and no new actions or allocations are needed for additional storage contracts. While an existing limit of 95 kAF exists in the 2008 BiOp, that opinion will be replaced by a new opinion no later than 2023¹, well before AI demand would reach this existing limit. The amount or existence of any future limit in the new opinion cannot be predicted at this time, so given existing legal mechanisms, we assume that issuing of storage contracts for AI up to the proposed allocated amount is sufficiently certain to occur.

Corps Agreements for M&I

The Corps already has the authority to enter into agreements for water storage for M&I purposes, and has examples from other projects of successful agreements they have entered into with M&I entities for reservoir storage space in other basins. While the proposed changes in character of use may be contested, as described above, once an allocation has been issued for M&I the existing legal framework and presence of similar agreements make it reasonably certain storage contracts for M&I will be issued up to the proposed allocated amount. Language in the ARP suggests a temporary limit on M&I contracts until reinitiation of the 2008 WVS is complete in 2023, but again the new opinion is expected to be completed well before the M&I stored water demand would reach that limit. We therefore assume contracts for storage will be issued as

¹ The 2008 Opinion is scheduled to expire at the end of 2023. However, it is also undergoing reinitiation of consultation, which is expected to be completed and result in a new opinion in 2023 or sooner.

demand is predicted to develop over the next 50 years, per the Corps' analysis in the revised draft FR/EA.

Corps Agreements for F&W

Oregon water law requires that a water user must enter into an agreement with the owner of a water storage facility before OWRD will issue a secondary water right to use that stored water. The proposed action assumes that a mechanism can be found to secure an agreement between Corps and ODFW for ODFW to be the holder of the right to stored water for F&W. This is critical to the intended use of the F&W water because as the holder of such an agreement, ODFW would call for the water to be released throughout the season (in coordination with the existing 2008 BiOp flow management team, at least until 2023). There are currently no examples of reservoir water contracts resulting in stored water rights held by ODFW despite this approach being attempted in other systems (e.g., the Deschutes River). It is within the Corps' authority to enter an MOU or other agreement with ODFW if an allocation exists, so it is sufficiently certain that the Corps would enter into such an agreement to allow ODFW to apply for secondary water rights. However, the lack of precedent for such storage agreements creates uncertainty around the potential for ODFW to hold F&W stored water rights for instream use. Given this uncertainty and the potential for OWRD to deny or modify the allocations requested in the transfer (as described above), it is not sufficiently certain that storage agreements will allow ODFW to apply for secondary water rights to use water stored for F&W to include this assumption in our analysis.

2.1.4 Secondary Water Rights

The proposed action assumes that once new users enter into storage agreements with BOR or the Corps they will apply for secondary water rights from OWRD. These secondary water rights would allow users to call for stored water to be released from the WVS dams, and for OWRD to protect the released water downstream. The proposed action assumes that secondary water rights will be issued consistent with the volumes requested by applicants. These secondary water rights are currently issued for AI stored water contract holders at the WVS and have been issued to municipal users in Oregon that have agreements for stored water from other agencies, so mechanisms exist to complete this part of the action. The issuance of secondary water rights to M&I and AI users therefore seems sufficiently certain to occur as anticipated in the proposed action.

However, when ODFW has applied for water rights in the past they have been contested (Woodcock and McCord 2018). Of the 946 instream water right applications and 506 minimum perennial streamflow conversions requested between 1988 and 1993 approximately 140 of them were protested and 62 protests still stand (Pakenham Stevenson, 2019). ODFW has requested 24 minimum perennial streamflows utilizing storage in the Willamette Basin be converted to instream water rights, yet in the 25 years or more since they were initially requested, none have been completed (Pakenham Stevenson, 2019, and Woodcock, 2019). Efforts to protect instream flows on the Crooked River in Oregon have similarly not resulted in secondary instream water rights for stored water being held by ODFW. There are currently no successful examples of enforceable secondary water rights granted to ODFW for stored water consistent with the

amounts and conditions requested. Instream water rights for fish and wildlife have been granted for the live flow component of some minimum perennial streamflows in Oregon, however most, if not all, were provided at a lower amount than ODFW requested and are subordinated to human consumption (and also livestock watering in some cases) (Pakenham Stevenson, 2019).

Given the previous record of issuing these instream protections for fish and wildlife in Oregon and the lack of progress made on these rights since the 2008 Willamette Valley Project was signed, it is not sufficiently certain that available mechanisms will result in ODFW holding secondary water rights for F&W to include this assumption in our analysis. It is also unclear at this time whether ODFW has the necessary resources to develop applications for all of the instream water rights and MPSF conversions expected to result from the proposed action.

2.1.5 Instream Water Rights Enforcement

Currently all flow released from a reservoir is considered “live” or “natural” flow, and may be legally withdrawn by water users with live flow water rights. Once the stored water is held as a secondary water right, OWRD can monitor withdrawals that may affect these secondary water rights, and if needed, notify junior users to stop diverting live flows (known as ‘regulating off’) to protect senior rights. If secondary water rights were granted for all users as assumed by the ARP, this would provide legal protection of instream flows for F&W throughout stream and tributary reaches which currently does not exist. However, as described above it is not sufficiently certain that the proposed action will result in ODFW holding enforceable secondary water rights, and therefore not certain that the intended protection of instream flows would be realized. NMFS does consider it reasonably certain that enforceable secondary water rights would be issued for new M&I and AI storage contract holders because of existing legal mechanisms.

It is not yet clear how effectively M&I and AI users would be regulated off when needed. More monitoring of AI withdrawals, potentially with totalizing flow meters, will be needed to ensure users do not exceed their total stored water volume over the conservation season. Similarly, M&I users that obtain stored water rights would need to monitor and report use levels, which is not currently required. OWRD has indicated they would require additional resources for monitoring and enforcement of all of the secondary water rights the proposed action assumes would be issued, and plan to obtain those resources as demand develops and new rights are issued over the project timeline (Woodcock and McCord 2018). The proposed action assumes that OWRD and the users they regulate will acquire the necessary mechanisms, resources, and communication plans to implement the annual management of WVS stored water as described in the proposed action. The funding and staffing level needed to achieve this and the changes in monitoring it would require are not currently described in enough detail to be considered sufficiently likely to occur, or to include this assumption in our analysis. However, enforcement mechanisms currently exist and the timeline of the development of these water rights makes it possible for OWRD to develop adequate enforcement resources and specific mechanisms in the future.

2.1.6 Guidelines for Managing Stored Water

The ARP also makes recommendations about how stored water will be reduced for the allocated uses when the total available storage is not available in a given year. The Corps proposed that for years where the system does not refill to 1.59 MAF users' available water would be reduced in proportion to the volume of conservation storage available (i.e. "proportionate reduction"). Under this plan the F&W allocation, M&I storage under contract, and AI storage under contract will be reduced so that each use category would receive the same percentage of the reduced conservation storage water as they would have if the full WVS capacity was available (USACE 2018a, 2018b, and 2018c). Each year, users would be notified by the Corps of the anticipated available stored water based on April forecasts, and system and allocation water volumes would be verified in June (USACE 2018a).

As mentioned above, the existing mechanism for enforcing existing secondary water rights is to "regulate off" junior users (i.e., upstream users with a later priority date). However, the Corps and OWRD have not determined how the contracted users would be regulated. For example, whether all water right holders in a use type would be reduced by the same amount or individual users would be regulated off by priority until the appropriate reduced total was reached. As this decision has not been made, it is also not clear how regulation and enforcement would have to change given existing infrastructure, procedures, and resources, and what the timing of notification and enforcement for users would be. The lack of detail surrounding how proportionate reduction will be implemented, monitored, and enforced makes it insufficiently certain that AI and M&I users would be regulated off in a way that ensures instream flows will be protected for F&W when the system does not fill.

Further, until under contract, stored water allocated for AI and M&I would be considered joint-use, and could be used for other authorized purposes. All water allocated for F&W would no longer be considered joint-use. The release of joint-use water to achieve these other project purposes would be determined by the existing interagency Flow Management Water Quality Team (FMWQT) which currently coordinates in-season management of conservation storage under the BiOp for operation of the WVS (NMFS 2008a). The Corps also proposes to continue developing an Annual Conservation Plan and coordinating with other federal and state agencies to implement their revised Drought Contingency Plan (USACE 2018a). It is reasonably certain that these existing mechanisms would continue to be used to manage joint-use water. This team also has representatives from the recreational community, and it is likely representatives of M&I and AI users would join these real-time discussions. Modeling of dam releases under the proposed action assumes that all joint-use water is released to meet instream flow targets for F&W (USACE 2018b), however FMWQT recommendations are likely to continue to be influenced by other water and reservoir uses in the basin. Given the current precedent of balancing multiple uses and increasing the number of users who will be affected by joint-use water releases it is not sufficiently certain joint-use water will be used to assure F&W beneficial uses as assumed in the BA analysis of effects. We assume that any water characterized as joint-use will be released for multiple beneficial uses, as it is currently through the FMWQT process,

and that as a result Reservoir System Simulation (ResSim)² modeling over-predicts the frequency with which existing minimum instream flow objectives will be met.

2.1.7 Timing, Duration, and Magnitude Assumptions

Demand for Stored Water

As the demand for AI and M&I water supply materializes over time, new contracts and water rights are expected to be issued. While there is currently no unmet demand for either of these use types, the proposed action assumes that residential populations in the Willamette Valley and in area of irrigated agricultural land will increase. The purpose of allocating volumes for specific use types is to allow them to be contracted for those uses, so increases in both M&I and AI contracts for storage beyond existing caps set to expire in 2023 is reasonably certain to occur over the next 50 years. For this reason we evaluated the effects of contracting the full allocations of water for M&I and AI, and did not limit this analysis to the temporary 2030 caps presented in the BA. M&I demand for stored water is expected to increase by anywhere from 56,632 acre-feet to 121,102 acre-feet from 2020 to 2070 (not including system redundancy demand), and AI demand over the same timeframe is predicted to increase from 100,128 acre-feet to 184,193 acre-feet (Appendix G of USACE 2018b), so contracting is expected to continue following these rates until the allocations are fully contracted.

Demand for and contracting of storage water is not expected to materialize uniformly across the Willamette Basin. Below are maps summarizing how M&I and AI contracts are expected to materialize between 2020 and 2070 (Figures 2.1-1 and 2.1-2, excerpted from USACE 2018a). For both M&I and AI, the increases are predominantly expected to be in the mainstem below the Santiam River, at 91.6% and 59.1% respectively. The next largest totals are for AI, where almost 15% of new demand is expected to come from the mainstem, North and South Santiam Rivers.

² ResSim or HEC-ResSim is Reservoir System Simulation software developed by the U.S. Army Corps of Engineers Institute for Water Resources Hydrologic Engineering Center. It is used to model reservoir operations at one or more reservoirs in a system and was used by the Corps to model predicted WVS flows in the BA (USACE 2018a) and draft FR/EA (USACE 2018b).

Spatial Distribution of M&I Demand for WVP Stored Water (2070)



Figure 2.1-1 Spatial Distribution of M&I Demand for WVS Stored Water (2070). From USACE 2018a.

Spatial Distribution of AI Demand for WVP Stored Water (2070)



Figure 2.1-2 Spatial Distribution of AI Demand for WVS Stored Water (2070). From USACE 2018a.

The timing of peak water use for AI and M&I uses differs from the current use of stored water for downstream beneficial uses under the 2008 BiOp. The release of water for new M&I and AI water contracts is expected to shift the distribution of existing releases to be higher in May, June, and July. This consequently results in proportionately less of the annual storage water releases being released in the fall compared to current conditions. This shift in the seasonal distribution of releases is expected to increase over time concurrently with the issuance of new AI and M&I water rights until these allocations are fully contracted (USACE 2018b).

While demand is expected to develop spatially as depicted above, there is no specific recommendation for how much storage could be allocated or contracted from each reservoir. Corps HEC ResSim modeling of the ARP used demands as distributed in the above maps with a specified order in which reservoirs would be drawn down that is consistent with current operations to inform their estimates, and we also assume operations will follow this pattern in our analyses.

Effects of Diversions of Contracted Water

To evaluate effects of the action over the timeline of the project, as required in ESA consultations (50 CFR 402), we used the data and analyses representing water use in the year 2070 as described in the revised Draft FR/EA information provided by the Corps (USACE 2018b). The Corps ran model simulations out to 2070 of “expected” and “peak” use scenarios which modeled the withdrawals and flows anticipated as a result of projecting future water use. These estimates were derived by applying projected growth in M&I users and irrigated acreage to average peak season M&I use and continuing trends of actual reported past diversions for irrigation (i.e., “expected” use) and to maximum rates of M&I use that could occur and legal maximum duty rates for AI (i.e., “peak” use) (Appendices A, B, and F of USACE 2018b).

We are required to evaluate the full range of potential effects of the actions, and so used the ‘peak use’ data presented in Section 9 of Appendix G of the revised Draft FR/EA (USACE 2018b) as a conservative estimate of the potential worst-case scenario. As described in Jaeger et al. (2017), demand for AI and M&I water is strongly dependent on cost. Prices for water use increase with increased conveyance and storage (AI) or the need for infrastructure upgrades and expansions (M&I), so water use declines for both M&I and AI users with increasing costs. One of the purposes of the proposed action, as described in the BA, is to provide stored water at “relatively low cost for domestic use” (USACE 2018a). We assume as shown by analyses in Jaeger et al. (2017) that providing this low cost supply will result in an increase in water use by AI and M&I users above what would be expected in the absence of a low-cost water source, which further supports our selection of peak 2070 rates for evaluation over other predictions based on current trends. This is also consistent with the Corps’ selection of these ‘peak use’ estimates as the basis for the ARP recommended allocation volumes (USACE 2018b).

As described in further detail in the Environmental Baseline and Effects of the Action (Sections 2.4 and 2.5) the modeling tool HEC ResSim, which was used to predict instream flows as a result of WVS operations, has been observed to overestimate how often minimum flow objectives will be met in some year types. Model assumptions about conditions during the period of record (1929 through 2007, USACE 2018b) and return flows that would be expected from M&I and AI

diversions are not sufficiently conservative to reflect the full range potential future conditions to which ESA-listed species may be exposed. Therefore, as described in Section 2.5 (Effects of the Action) we use the Corps' raw estimates of the withdrawals themselves, rather than ResSim's reservoir management predictions, for a more conservative estimate of potential changes to current flow target performance resulting from the proposed action. As described in more detail in the effects section, analysis of flow effects is based on withdrawals as predicted by the Corps' draft FR/EA as they would apply to recently recorded United States Geological Survey (USGS) flow data, and evaluated potential temperature effects under current and future climate conditions.

2.2 Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each species that would be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential PBFs that help to form that conservation value.

One factor affecting the status of ESA-listed species considered in this opinion, and aquatic habitat at large, is climate change. Climate change is likely to play an increasingly important role in determining the abundance and distribution of ESA-listed species, and the conservation value of designated critical habitats, in the Pacific Northwest. These changes will not be spatially homogeneous across the Pacific Northwest. The largest hydrologic responses are expected to occur in basins with significant snow accumulation, where warming decreases snow pack, increases winter flows, and advances the timing of spring melt (Mote et al. 2014, Mote et al. 2016). Rain-dominated watersheds and those with significant contributions from groundwater may be less sensitive to predicted changes in climate (Tague et al. 2013, Mote et al. 2014).

During the last century, average regional air temperatures in the Pacific Northwest increased by 1-1.4°F as an annual average, and up to 2°F in some seasons (based on average linear increase per decade; Abatzoglou et al. 2014; Kunkel et al. 2013). Warming is likely to continue during the next century as average temperatures are projected to increase another 3 to 10°F, with the largest increases predicted to occur in the summer (Mote et al. 2014). Decreases in summer precipitation of as much as 30% by the end of the century are consistently predicted across climate models (Mote et al. 2014). Precipitation is more likely to occur during October through March, less during summer months, and more winter precipitation will be rain than snow (ISAB 2007; Mote et al. 2013; Mote et al. 2014). Earlier snowmelt will cause lower stream flows in late spring, summer, and fall, and water temperatures will be warmer (ISAB 2007; Mote et al. 2014). Models consistently predict increases in the frequency of severe winter precipitation events (i.e., 20-year and 50-year events), in the western United States (Dominguez et al. 2012). The largest increases

in winter flood frequency and magnitude are predicted in mixed rain-snow watersheds (Mote et al. 2014).

Overall, about one-third of the current cold-water salmonid habitat in the Pacific Northwest is likely to exceed key water temperature thresholds by the end of this century (Mantua et al. 2009). Higher temperatures will reduce the quality of available salmonid habitat for most freshwater life stages (ISAB 2007). Reduced flows will make it more difficult for migrating fish to pass physical and thermal obstructions, limiting their access to available habitat (Mantua et al. 2010; Isaak et al. 2012). Temperature increases shift timing of key life cycle events for salmonids and species forming the base of their aquatic food webs (Crozier et al. 2011; Tillmann and Siemann 2011; Winder and Schindler 2004). Higher stream temperatures will also cause decreases in dissolved oxygen and may also cause earlier onset of stratification and reduced mixing between layers in lakes and reservoirs, which can also result in reduced oxygen (Meyer et al. 1999; Winder and Schindler 2004, Raymondi et al. 2013). Higher temperatures are likely to cause several species to become more susceptible to parasites, disease, and higher predation rates (Crozier et al. 2008; Wainwright and Weitkamp 2013; Raymondi et al. 2013).

As more basins become rain-dominated and prone to more severe winter storms, higher winter stream flows may increase the risk that winter or spring floods in sensitive watersheds will damage spawning redds and wash away incubating eggs (Goode et al. 2013). Earlier peak stream flows will also alter migration timing for salmon smolts, and may flush some young salmon and steelhead from rivers to estuaries before they are physically mature, increasing stress and reducing smolt survival (McMahon and Hartman 1989; Lawson et al. 2004).

In addition to changes in freshwater conditions, predicted changes for coastal waters in the Pacific Northwest as a result of climate change include increasing surface water temperature, increasing but highly variable acidity, and increasing storm frequency and magnitude (Mote et al. 2014). Elevated ocean temperatures already documented for the Pacific Northwest are highly likely to continue during the next century, with sea surface temperature projected to increase by 1.0-3.7°C by the end of the century (IPCC 2014). Habitat loss, shifts in species' ranges and abundances, and altered marine food webs could have substantial consequences to anadromous, coastal, and marine species in the Pacific Northwest (Tillmann and Siemann 2011, Reeder et al. 2013). Moreover, as atmospheric carbon emissions increase, increasing levels of carbon are absorbed by the oceans, changing the pH of the water. Acidification also impacts sensitive estuary habitats, where organic matter and nutrient inputs further reduce pH and produce conditions more corrosive than those in offshore waters (Feely et al. 2012, Sunda and Cai 2012).

Global sea levels are expected to continue rising throughout this century, reaching likely predicted increases of 10-32 inches by 2081-2100 (IPCC 2014). These changes will likely result in increased erosion and more frequent and severe coastal flooding, and shifts in the composition of nearshore habitats (Tillmann and Siemann 2011, Reeder et al. 2013). Estuarine-dependent salmonids such as chum and Chinook salmon are predicted to be impacted by significant reductions in rearing habitat in some Pacific Northwest coastal areas (Glick et al. 2007).

Historically, warm periods in the coastal Pacific Ocean have coincided with relatively low abundances of salmon and steelhead, while cooler ocean periods have coincided with relatively

high abundances, and therefore these species are predicted to fare poorly in warming ocean conditions (Scheuerell and Williams 2005; Zabel et al. 2006). This is supported by the recent observation that anomalously warm sea surface temperatures off the coast of Washington from 2013 to 2016 resulted in poor coho and Chinook salmon body condition for juveniles caught in those waters (NWFSC 2015). Changes to estuarine and coastal conditions, as well as the timing of seasonal shifts in these habitats, have the potential to impact a wide range of listed aquatic species (Tillmann and Siemann 2011, Reeder et al. 2013).

The adaptive ability of these threatened and endangered species is depressed due to reductions in population size, habitat quantity and diversity, and loss of behavioral and genetic variation. Without these natural sources of resilience, systematic changes in local and regional climatic conditions due to anthropogenic global climate change will likely reduce long-term viability and sustainability of populations in many of these ESUs (NWFSC 2015). New stressors generated by climate change, or existing stressors with effects that have been amplified by climate change, may also have synergistic impacts on species and ecosystems (Doney et al. 2012). These conditions will possibly intensify the climate change stressors inhibiting recovery of ESA-listed species in the future.

2.2.1 Status of the Species

Table 2.2-1, below provides a summary of listing and recovery plan information, status summaries and limiting factors for the species addressed in this opinion. More information can be found in recovery plans and status reviews for these species. These documents are available on the NMFS West Coast Region website (<http://www.westcoast.fisheries.noaa.gov/>).

Table 2.2-1 Listing classification and date, recovery plan reference, most recent status review, status summary, and limiting factors for each species considered in this opinion.

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Lower Columbia River Chinook salmon	Threatened 6/28/05	NMFS 2013	NWFSC 2015	This ESU comprises 32 independent populations. Twenty-seven populations are at very high risk, 2 populations are at high risk, one population is at moderate risk, and 2 populations are at very low risk. Overall, there was little change since the last status review in the biological status of this ESU, although there are some positive trends. Increases in abundance were noted in about 70% of the fall-run populations and decreases in hatchery contribution were noted for several populations. Relative to baseline VSP levels identified in the recovery plan, there has been an overall improvement in the status of a number of fall-run populations, although most are still far from the recovery plan goals.	<ul style="list-style-type: none"> • Reduced access to spawning and rearing habitat • Hatchery-related effects • Harvest-related effects on fall Chinook salmon • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Contaminant
Upper Columbia River spring-run Chinook salmon	Endangered 6/28/05	Upper Columbia Salmon Recovery Board 2007	NWFSC 2015	This ESU comprises four independent populations. Three are at high risk and one is functionally extirpated. Current estimates of natural origin spawner abundance increased relative to the levels observed in the prior review for all three extant populations, and productivities were higher for the Wenatchee and Entiat populations and unchanged for the Methow population. However, abundance and productivity remained well below the viable thresholds called for in the Upper Columbia Recovery Plan for all three populations.	<ul style="list-style-type: none"> • Effects related to hydropower system in the mainstem Columbia River • Degraded freshwater habitat • Degraded estuarine and nearshore marine habitat • Hatchery-related effects • Persistence of non-native (exotic) fish species • Harvest in Columbia River fisheries
Snake River spring/summer-run Chinook salmon	Threatened 6/28/05	NMFS 2017a	NWFSC 2015	This ESU comprises 28 extant and four extirpated populations. All except one extant population (Chamberlin Creek) are at high risk. Natural origin abundance has increased over the levels reported in the prior review for most populations in this ESU, although the increases were not substantial enough to change viability ratings. Relatively high ocean survivals in recent years were a major factor in recent abundance	<ul style="list-style-type: none"> • Degraded freshwater habitat • Effects related to the hydropower system in the mainstem Columbia River, • Altered flows and degraded water quality • Harvest-related effects • Predation

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				patterns. While there have been improvements in abundance and productivity in several populations relative to prior reviews, those changes have not been sufficient to warrant a change in ESU status.	
Upper Willamette River Chinook salmon	Threatened 6/28/05	ODFW and NMFS 2011	NWFSC 2015	This ESU comprises seven populations. Five populations are at very high risk, one population is at moderate risk (Clackamas River) and one population is at low risk (McKenzie River). Consideration of data collected since the last status review in 2010 indicates the fraction of hatchery origin fish in all populations remains high (even in Clackamas and McKenzie populations). The proportion of natural origin spawners improved in the North and South Santiam basins, but is still well below identified recovery goals. Abundance levels for five of the seven populations remain well below their recovery goals. Of these, the Calapooia River may be functionally extinct and the Molalla River remains critically low. Abundances in the North and South Santiam rivers have risen since the 2010 review, but still range only in the high hundreds of fish. The Clackamas and McKenzie populations have previously been viewed as natural population strongholds, but have both experienced declines in abundance despite having access to much of their historical spawning habitat. Overall, populations appear to be at either moderate or high risk, there has been likely little net change in the VSP score for the ESU since the last review, so the ESU remains at moderate risk.	<ul style="list-style-type: none"> • Degraded freshwater habitat • Degraded water quality • Increased disease incidence • Altered stream flows • Reduced access to spawning and rearing habitats • Altered food web due to reduced inputs of microdetritus • Predation by native and non-native species, including hatchery fish • Competition related to introduced salmon and steelhead • Altered population traits due to fisheries and bycatch
Snake River fall-run Chinook salmon	Threatened 6/28/05	NMFS 2017b	NWFSC 2015	This ESU has one extant population. Historically, large populations of fall Chinook salmon spawned in the Snake River upstream of the Hells Canyon Dam complex. The extant population is at moderate risk for both diversity and spatial structure and abundance and productivity. The overall viability rating for this	<ul style="list-style-type: none"> • Degraded floodplain connectivity and function • Harvest-related effects • Loss of access to historical habitat above Hells Canyon and other Snake River dams • Impacts from mainstem Columbia River and Snake River hydropower systems

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				population is 'viable.' Overall, the status of Snake River fall Chinook salmon has clearly improved compared to the time of listing and compared to prior status reviews. The single extant population in the ESU is currently meeting the criteria for a rating of 'viable' developed by the ICTRT, but the ESU as a whole is not meeting the recovery goals described in the recovery plan for the species, which require the single population to be "highly viable with high certainty" and/or will require reintroduction of a viable population above the Hells Canyon Dam complex.	<ul style="list-style-type: none"> • Hatchery-related effects • Degraded estuarine and nearshore habitat.
Columbia River chum salmon	Threatened 6/28/05	NMFS 2013	NWFSC 2015	Overall, the status of most chum salmon populations is unchanged from the baseline VSP scores estimated in the recovery plan. A total of 3 of 17 populations are at or near their recovery viability goals, although under the recovery plan scenario these populations have very low recovery goals of 0. The remaining populations generally require a higher level of viability and most require substantial improvements to reach their viability goals. Even with the improvements observed during the last five years, the majority of populations in this ESU remain at a high or very high risk category and considerable progress remains to be made to achieve the recovery goals.	<ul style="list-style-type: none"> • Degraded estuarine and nearshore marine habitat • Degraded freshwater habitat • Degraded stream flow as a result of hydropower and water supply operations • Reduced water quality • Current or potential predation • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat in the lower Columbia River • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Juvenile fish wake strandings • Contaminants
Lower Columbia River coho salmon	Threatened 6/28/05	NMFS 2013	NWFSC 2015	Of the 24 populations that make up this ESU, 21 populations are at very high risk, 1 population is at high risk, and 2 populations are at moderate risk. Recent recovery efforts may have contributed to the observed natural production, but in the absence of longer term data sets it is not possible to parse out these effects. Populations with longer term data sets exhibit stable or slightly positive abundance trends. Some trap and haul programs appear to be operating at or near replacement, although other	<ul style="list-style-type: none"> • Degraded estuarine and near-shore marine habitat • Fish passage barriers • Degraded freshwater habitat: Hatchery-related effects • Harvest-related effects • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat in the lower Columbia River

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				programs still are far from that threshold and require supplementation with additional hatchery-origin spawners. Initiation of or improvement in the downstream juvenile facilities at Cowlitz Falls, Merwin, and North Fork Dam are likely to further improve the status of the associated upstream populations. While these and other recovery efforts have likely improved the status of a number of coho salmon populations, abundances are still at low levels and the majority of the populations remain at moderate or high risk. For the Lower Columbia River region land development and increasing human population pressures will likely continue to degrade habitat, especially in lowland areas. Although populations in this ESU have generally improved, especially in the 2013/14 and 2014/15 return years, recent poor ocean conditions suggest that population declines might occur in the upcoming return years	<ul style="list-style-type: none"> • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Juvenile fish wake strandings • Contaminants
Snake River sockeye salmon	Endangered 6/28/05	NMFS 2015	NWFSC 2015	This single population ESU is at very high risk due to small population size. There is high risk across all four basic risk measures. Although the captive brood program has been successful in providing substantial numbers of hatchery produced fish for use in supplementation efforts, substantial increases in survival rates across all life history stages must occur to re-establish sustainable natural production. In terms of natural production, the Snake River Sockeye ESU remains at extremely high risk although there has been substantial progress on the first phase of the proposed recovery approach – developing a hatchery based program to amplify and conserve the stock to facilitate reintroductions.	<ul style="list-style-type: none"> • Effects related to the hydropower system in the mainstem Columbia River • Reduced water quality and elevated temperatures in the Salmon River • Water quantity • Predation
Upper Columbia River steelhead	Threatened 1/5/06	Upper Columbia Salmon Recovery Board 2007	NWFSC 2015	This DPS comprises four independent populations. Three populations are at high risk of extinction while 1 population is at moderate risk. Upper Columbia River steelhead populations have increased relative to the low levels	<ul style="list-style-type: none"> • Adverse effects related to the mainstem Columbia River hydropower system • Impaired tributary fish passage • Degraded floodplain connectivity and function, channel structure and complexity.

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				observed in the 1990s, but natural origin abundance and productivity remain well below viability thresholds for three out of the four populations. The status of the Wenatchee River steelhead population continued to improve based on the additional year's information available for the most recent review. The abundance and productivity viability rating for the Wenatchee River exceeds the minimum threshold for 5% extinction risk. However, the overall DPS status remains unchanged from the prior review, remaining at high risk driven by low abundance and productivity relative to viability objectives and diversity concerns.	<ul style="list-style-type: none"> riparian areas, large woody debris recruitment, stream flow, and water quality • Hatchery-related effects • Predation and competition • Harvest-related effects
Lower Columbia River steelhead	Threatened 1/5/06	NMFS 2013	NWFSC 2015	This DPS comprises 23 historical populations, 17 winter-run populations and six summer-run populations. Nine populations are at very high risk, 7 populations are at high risk, 6 populations are at moderate risk, and 1 population is at low risk. The majority of winter-run steelhead populations in this DPS continue to persist at low abundances. Hatchery interactions remain a concern in select basins, but the overall situation is somewhat improved compared to prior reviews. Summer-run steelhead populations were similarly stable, but at low abundance levels. The decline in the Wind River summer-run population is a source of concern, given that this population has been considered one of the healthiest of the summer-runs; however, the most recent abundance estimates suggest that the decline was a single year aberration. Passage programs in the Cowlitz and Lewis basins have the potential to provide considerable improvements in abundance and spatial structure, but have not produced self-sustaining populations to date. Even with modest improvements in the status of several winter-run DIPs, none of the populations appear to be at	<ul style="list-style-type: none"> • Degraded estuarine and nearshore marine habitat • Degraded freshwater habitat • Reduced access to spawning and rearing habitat • Avian and marine mammal predation • Hatchery-related effects • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat in the lower Columbia River • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Juvenile fish wake strandings • Contaminants

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Upper Willamette River steelhead	Threatened 1/5/06	ODFW and NMFS 2011	NWFSC 2015	<p>fully viable status, and similarly none of the MPGs meet the criteria for viability.</p> <p>This DPS has four demographically independent populations. Three populations are at low risk and one population is at moderate risk. Declines in abundance noted in the last status review continued through the period from 2010-2015. While rates of decline appear moderate, the DPS continues to demonstrate the overall low abundance pattern that was of concern during the last status review. The causes of these declines are not well understood, although much accessible habitat is degraded and under continued development pressure. The elimination of winter-run hatchery release in the basin reduces hatchery threats, but non-native summer steelhead hatchery releases are still a concern for species diversity and a source of competition for the DPS. While the collective risk to the persistence of the DPS has not changed significantly in recent years, continued declines and potential negative impacts from climate change may cause increased risk in the near future.</p>	<ul style="list-style-type: none"> • Degraded freshwater habitat • Degraded water quality • Increased disease incidence • Altered stream flows • Reduced access to spawning and rearing habitats due to impaired passage at dams • Altered food web due to changes in inputs of microdetritus • Predation by native and non-native species, including hatchery fish and pinnipeds • Competition related to introduced salmon and steelhead • Altered population traits due to interbreeding with hatchery origin fish
Middle Columbia River steelhead	Threatened 1/5/06	NMFS 2009b	NWFSC 2015	<p>This DPS comprises 17 extant populations. The DPS does not currently include steelhead that are designated as part of an experimental population above the Pelton Round Butte Hydroelectric Project. Returns to the Yakima River basin and to the Umatilla and Walla Walla Rivers have been higher over the most recent brood cycle, while natural origin returns to the John Day River have decreased. There have been improvements in the viability ratings for some of the component populations, but the DPS is not currently meeting the viability criteria in the MCR steelhead recovery plan. In general, the majority of population level viability ratings remained unchanged from prior reviews for each major population group within the DPS.</p>	<ul style="list-style-type: none"> • Degraded freshwater habitat • Mainstem Columbia River hydropower-related impacts • Degraded estuarine and nearshore marine habitat • Hatchery-related effects • Harvest-related effects • Effects of predation, competition, and disease

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Snake River basin steelhead	Threatened 1/5/06	NMFS 2017a	NWFSC 2015	This DPS comprises 24 populations. Two populations are at high risk, 15 populations are rated as maintained, 3 populations are rated between high risk and maintained, 2 populations are at moderate risk, 1 population is viable, and 1 population is highly viable. Four out of the five MPGs are not meeting the specific objectives in the draft recovery plan based on the updated status information available for this review, and the status of many individual populations remains uncertain. A great deal of uncertainty still remains regarding the relative proportion of hatchery fish in natural spawning areas near major hatchery release sites within individual populations.	<ul style="list-style-type: none"> • Adverse effects related to the mainstem Columbia River hydropower system • Impaired tributary fish passage • Degraded freshwater habitat • Increased water temperature • Harvest-related effects, particularly for B-run steelhead • Predation • Genetic diversity effects from out-of-population hatchery releases

Status of UWR Species

The UWR Chinook salmon and steelhead are expected to be exposed to a wider range of effects as a result of the proposed action, as well as effects of greater magnitude and duration, than any other species considered in this opinion. Consequently, the status of these species is discussed in greater detail. Additional information is provided for specific UWR Chinook salmon and steelhead populations in tributaries which may be affected by the proposed action, i.e., tributaries with Willamette Valley Project dams and reservoirs.

UWR Chinook salmon

There are a number of general considerations that affect some or all of the UWR Chinook salmon populations, including high levels of prespawning mortality,³ lack of access to historical habitat, high levels of total dissolved gases (TDG), and a reduction in returning adult abundance between Willamette Falls and census points in the main tributaries (NWFSC 2015). Prespawning mortality levels are generally high in the lower tributary reaches where water temperatures and fish densities are the highest. Access to historical spawning and rearing areas is restricted by large dams in the four historically most productive tributaries (Figure 2.2-1), and in the absence of effective passage programs will continue to confine spawning to more lowland reaches where land development, water temperatures, and water quality may be limiting. Areas immediately downstream of high head dams may also be subject to high levels of total dissolved gas (TDG), which could affect a significant portion of the incubating embryos, in-stream juveniles, and adults in the basin, although the effect has not been quantified (NWFSC 2015). Shortfalls in counts of returning adults between Willamette Falls and upper tributary reaches also indicate additional prespawning mortality or spawning in lower quality habitat in lower tributary reaches could be limiting the recovery of these populations (Jepson et al. 2013; Jepson et al. 2014).

UWR Chinook salmon returning to Willamette Falls showed a downward trend in natural origin adult returns from 2010-2014 (Figure 2.2-2) (NWFSC 2015). These counts appear to be increasingly influenced by pinniped predation at the base of Willamette Falls in recent years, with estimates indicating California sea lions consumed on average 6 to 9% of the total potential escapement of natural origin UWR Chinook salmon between 2014 and 2018 (ODFW 2018a). In addition, there is a shortfall in abundance between Chinook salmon counted at Willamette Falls and those which arrive at east-side (i.e., ESU population) tributary census points due to unquantified pre-spawning mortality or spawning in downstream reaches or west side tributaries where spawning and incubation conditions are less well-suited to UWR Chinook salmon (NWFSC 2015).

³ Females that were found dead with most or significant fraction of their eggs are classified as prespawning mortalities.

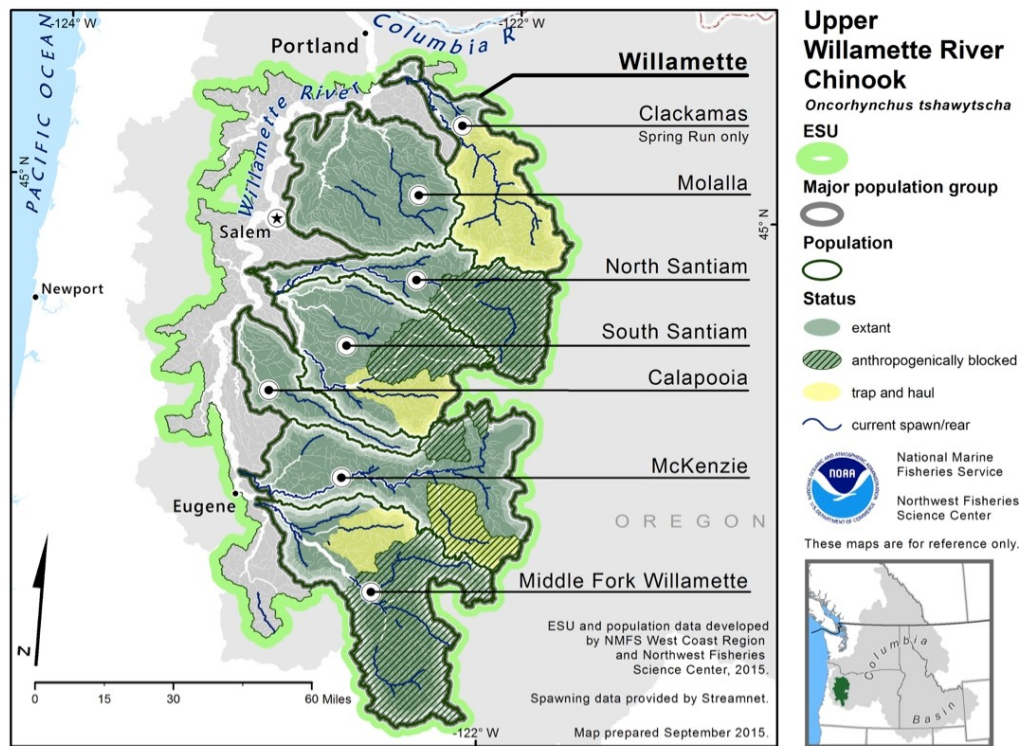


Figure 2.2-1 Map of the Upper Willamette River Chinook salmon ESU's spawning and rearing areas, illustrating populations and major population groups (NWFSC 2015)

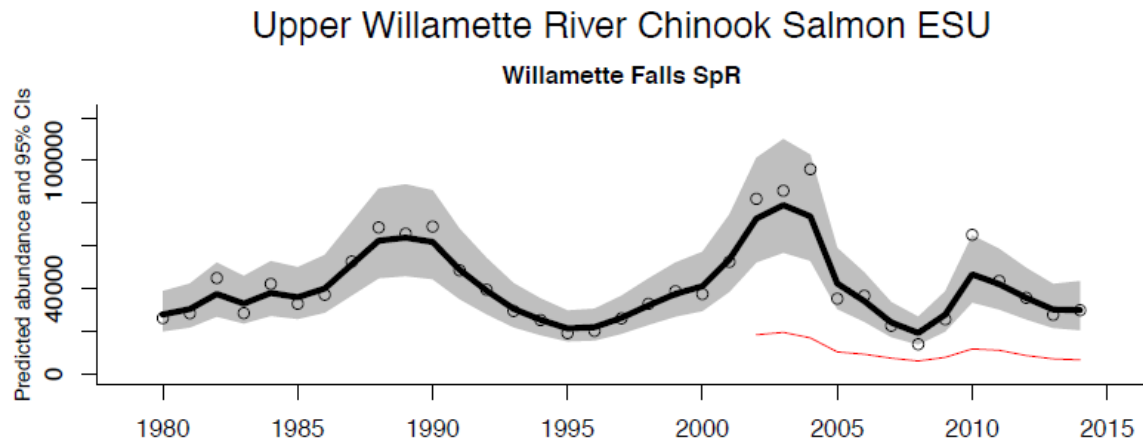


Figure 2.2-2 Smoothed trend in estimated total (thick black line) and natural (thin red line) Willamette Falls counts and population spawning abundance of UWR Chinook salmon (NWFSC 2015). Points show the annual raw spawning abundance estimates.

There was a large run of UWR Chinook salmon in 2015, with 51,046 total adults (9,954 natural-origin adults) counted at Willamette Falls. However, since 2015 returning adult abundance at Willamette Falls has been below the 5-year geometric mean from the time of the last status review for both natural-origin and total adult returns (Table 2.2-2).

Table 2.2-2 UWR Chinook salmon adult abundance at Willamette Falls. The 5-year geometric mean of Willamette Falls counts from 2010-2014 was calculated at the time of the last status review (NWFSC 2015). Counts for later years were obtained from the Willamette Falls annual fish counts (ODFW 2018b).

Year	Natural Origin Adults	Total Adults
2010-2014 (5-year geometric mean)	9,269	38,630
2015	9,954	51,046
2016	6,639	30,317
2017	6,087	34,198
2018	5,015	24,543

In the four historically most productive east-side tributaries, access to historical spawning and rearing habitat is restricted by large dams, confining natural origin UWR Chinook salmon to more lowland reaches with less suitable water quality and habitat until effective fish passage programs are in place. These limiting factors, in addition to current climate conditions and the prospect of long-term climate change, may put this ESU at greater risk in the near future (NWFSC 2015).

Prespawning mortality of adult UWR Chinook salmon has been a factor likely limiting productivity. Some populations have experienced over 80% loss of adults prior to spawning (Bowerman et al. 2018, Sharpe et al. 2017). Poor water quality (high temperatures) and overcrowding of spawners below the dams have been shown to be associated with higher prespawning mortality rates of adult UWR Chinook salmon (Bowerman et al. 2018). When UWR Chinook salmon have natural access to headwater habitat areas where the fish can over-summer in cooler waters mortality rates have been lower (Bowerman et al. 2018).

Juvenile emigration patterns of the UWR Chinook salmon are complicated, and include traits from both ocean- and stream-type life histories (Figure 2.2-3). Smolt emigrations occur both as subyearlings, consistent with ocean-type life histories, and as yearlings, consistent with stream-type life histories, in the fall and spring (Figure 2.2-3) (Schroeder et al. 2015). It is assumed that both yearlings and subyearlings spend some amount of time rearing in lower tributaries and the mainstem Willamette River, with subyearling outmigrants spending from a few months to an entire year rearing in habitats below WVS dams in the action area.

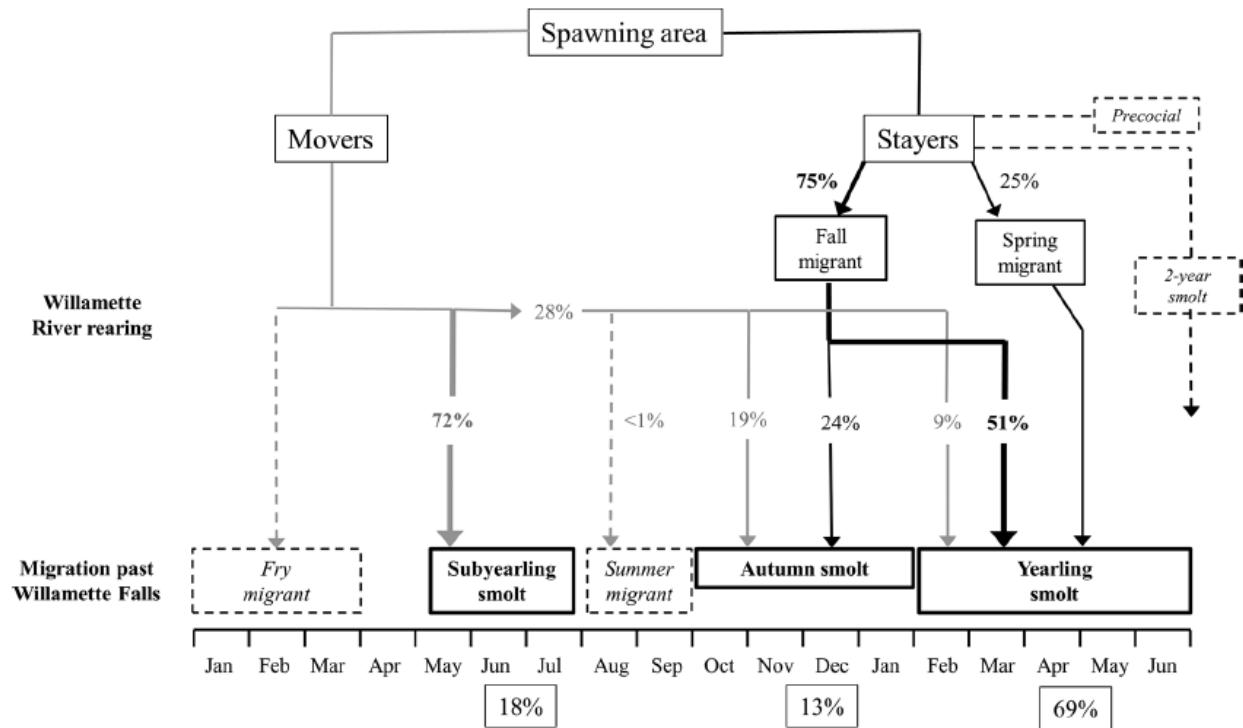


Figure 2.2-3 Juvenile UWR Chinook salmon life history types in the Willamette River. Figure taken from Schroeder et al. (2015).

Ocean distribution of this ESU is consistent with an ocean-type life history, with the majority of UWR Chinook salmon caught off the coasts of British Columbia and Alaska. Chinook from the Willamette River have the earliest return timing of all Chinook salmon stocks in the Columbia Basin, with freshwater entry beginning in February. At present, adults return to the Willamette River primarily at ages 3 through 5, with age 4 fish being most abundant (Johnson and Friesen 2014). Historically, age 5 fish were most abundant, and spawning occurred between mid-July and late October. The current spawn timing of both hatchery and natural-origin UWR Chinook salmon is August through October, peaking in September (ODFW and NMFS 2011).

Overall Status of ESU

In the latest status review of the UWR, the risk ratings stayed the same as the previous status review, but the measurements of the Viable Salmonid Population (VSP)⁴ scores showed that there is some decline in the scores (Figure 2.2-4). As stated by NWFSC (2015):

Although there has likely been an overall decrease in the VSP status of the ESU since the last review, the magnitude of this change is not sufficient to suggest a change in risk category. Given current climatic conditions and the prospect of long-term climatic change, the inability of many populations to access historical headwater spawning and rearing areas may put this ESU at greater risk in the near future.

⁴ Viable Salmonid Population (VSP) is a concept developed by McElhany et al. (2000) which evaluates four criteria – abundance, productivity, spatial structure, and diversity – to assess species viability.

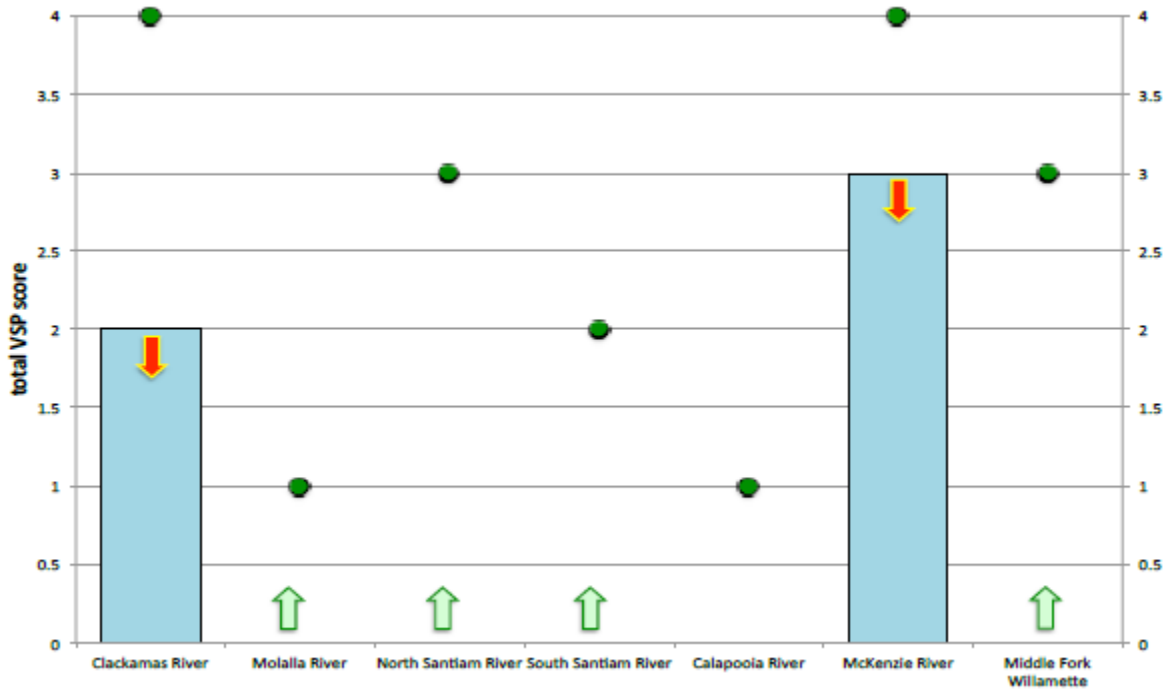


Figure 2.2-4 VSP status of UWR Chinook salmon populations. Green circles show recovery goal. Blue bars show previous VSP status. Red and green arrows show general direction of current status. Figure taken from NWFSC (2015).

Current Limiting Factors

The ESA recovery plan (ODFW and NMFS 2011) identifies the current limiting factors/threats for each of the populations in the UWR Chinook salmon ESU:

- Degraded freshwater habitat, including floodplain connectivity and function, channel structure and complexity, incubation gravels, riparian areas, and gravel and large wood recruitment
- Degraded water quality including elevated water temperature and toxins
- Increased disease incidence
- Altered stream flows
- Reduced access to spawning and rearing habitats due to migration barriers, impaired fish passage, and increased pre-spawn mortality associated with conditions below dams
- Altered food web due to reduced inputs of microdetritus
- Predation by native and non-native species, including hatchery fish
- Competition related to introduced races of salmon and steelhead
- Altered population traits due to fisheries, bycatch, and natural origin fish interbreeding with hatchery origin fish

In summary, habitat loss and degradation associated with the WVS dams is currently limiting production in the North Santiam, South Santiam, McKenzie, and Middle Fork Willamette River populations. For the Molalla and Calapooia River populations, habitat loss and degradation

associated with land management and urbanization is currently the most pressing threat limiting productivity.

In addition, the most recent 5-year status review of UWR Steelhead and Chinook salmon (NMFS 2016a) noted that despite recent improvements in habitat due to Federal, State, county and tribal regulatory mechanisms now in place there remain concerns about the adequacy of existing regulatory mechanisms. Specific examples of such inadequacies included that certain federal, state, and local land and water decisions continue to occur without the benefit of ESA review, and that for federal actions there continues to be confusion among some entities as to the relationship between ESA mandates, federal preemption, and the primacy of regulatory obligations that impairs or prevents the consultation process (NMFS 2016a). While the lack of instream flow protections for fish is not specifically mentioned, as described in this opinion, NMFS considers implementation of such protections in the Willamette Basin (as required by NMFS' 2008 biological opinion on the WVS, NMFS 2008a) to be critical for the survival and recovery of UWR Chinook salmon. Currently, there is no mechanism to protect stored water released from WVS dams as instream flow, but protections are necessary to address the limiting factor of altered stream flows.

Fishery harvest impacts have been substantially reduced since ESA listing and is no longer impeding the recovery of the ESU (ODFW and NMFS 2011). Hatchery programs pose risks and benefits to Chinook salmon from genetic introgression of hatchery fish in wild populations (risk) to increased abundance from reintroduction above the dams using hatchery fish (benefit). Predation in the reservoirs, mainstem Willamette River, Willamette Falls, lower Columbia River and estuary by non-native fish species, marine mammals, Caspian terns and cormorants continues to impact both adult and juvenile Chinook salmon. However, in 2018 the ODFW received authorization to remove California sea lions under Section 120 of the Marine Mammal Protection Act (NMFS 2018), and implementation of this authority is expected to decrease predation of adult Chinook salmon and steelhead specifically at Willamette Falls in the future.

North Santiam Population

Adult natural-origin returns (NOR) of Chinook salmon to the North Santiam River, as measured at Bennett Dam, exhibited an increase in mean abundance from 2010-2014 compared to previous years, in contrast to many of the other populations in the ESU and the combined count at Willamette Falls (NWFSC 2015). This may be related to improved fish passage at Bennett Dam or recent changes to temperature control operations at Detroit Dam, resulting in reduced pre-spawn mortality of adults and an incubation regime more similar to pre-dam conditions. However, since 2015 total numbers of returning adults, both hatchery and natural-origin, have continued to be low relative to counts prior to 2005 (Figure 2.2-5). In addition, estimates of adult spawners in the North Santiam based on redd counts are only a fraction (ranging from one half to one fifth) of the total number of adults counted at Bennett Dam from 2014-2016 (ODFW 2018b).

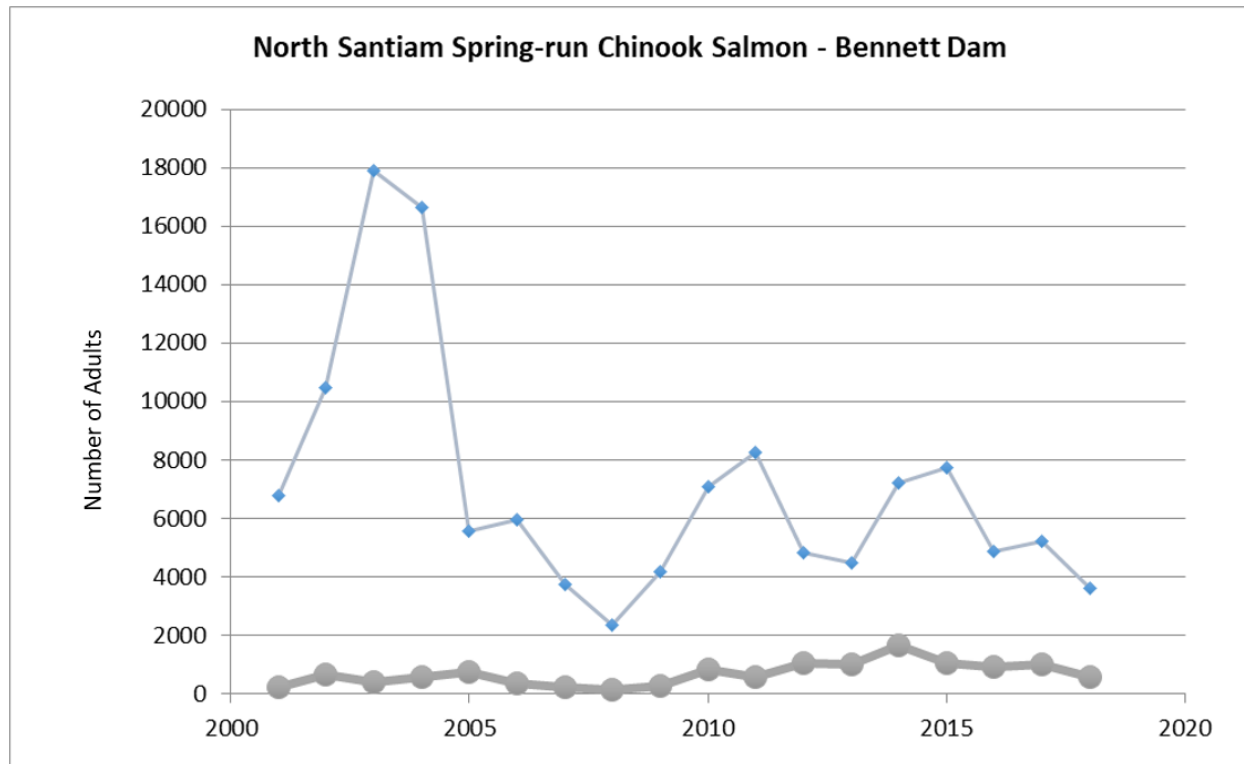


Figure 2.2-5 Counts of returning adult UWR Chinook salmon counted at Upper and Lower Bennett Dams. The blue line indicates total adults, and the gray line indicates unmarked natural-origin adults. Data from ODFW publicly available fish counts (ODFW 2018b).

Table 2.2-3 Periodicity table for UWR Chinook salmon in the North Santiam River below Big Cliff Dam. From the Willamette Fish Operations Plan (USACE 2018d)

Life Stage/Activity/Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upstream Adult Migration												
Adult Spawning												
Adult Holding												
Egg Incubation through Fry Emergence												
Juvenile Rearing												
All life stages												
Fry												
Subyearling												
Fall migrant												
Yearling												
Downstream Juvenile Migration												
Dec-Mar = fry												
April-mid July = subyearling												
Mar-May = yearling smolts;												
mid-Oct-mid Dec = fall migrants												
<div> <div></div> Represents periods of peak use based on professional opinion. <div></div> Represents lesser level of use based on professional opinion. <div></div> shaded cells represent information based on field data & direct knowledge <div></div> red cells represent critical periods when flow fluctuations should be avoided to prevent disruption of spawning, to minimize disturbance of eggs during early incubation, and to minimize stranding or displacing newly emerged fry </div>												

South Santiam Population





Spring-run Chinook salmon adults returning to the South Santiam River are monitored via redd counts and carcass recoveries in the mainstem South Santiam as there are no counting stations below Foster Dam. Direct counts of returning adults are made at the Foster fish collection facility at Foster Dam, where only natural-origin adults are passed above the dam. Foster Dam counts may be biased by conditions at the adult trap below Foster Dam, because not all fish produced upstream of the dam are attracted to the trap. Additionally, some of the NORs that enter the trap may be the offspring of spawners from reaches below the dam.

Available data from Foster Dam from the most recent status review (2007-2014) showed the abundance of NOR spawners has exhibited a positive trend (NWFSC 2015). Counts since 2014 have ranged from 1,670 to 7,152 adults, relative to the 2010-2014 geometric mean of 1,686, potentially reflecting improved passage conditions after completion of the Foster Adult Fish Facility in 2014 (ODFW 2018b). It appears that juvenile passage through Foster Dam is sufficiently high to sustain a naturally-spawning aggregation above the Dam, although total abundance is still quite low. Genetic analysis indicates that the replacement rates for the 2007

and 2008 brood years were 0.96 and 1.16, respectively (O'Malley et al. 2014). Efforts are currently underway to improve both adult collection and juvenile downstream passage at Foster Dam.

Table 2.2-4 Periodicity table for UWR Chinook salmon in the South Santiam River below Foster Dam. From the Willamette Fish Operations Plan (USACE 2018d)

Life Stage/Activity/Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upstream Adult Migration												
Adult Spawning												
Adult Holding												
Egg Incubation through Fry Emergence												
Juvenile Rearing												
All life stages												
Fry												
Subyearling												
Fall migrant												
Yearling												
Downstream Juvenile Migration												
Dec-Mar = fry												
April-mid July = subyearling												
Mar-May = yearling smolts;												
mid-Oct-mid Dec = fall migrants												

	Represents periods of peak use based on professional opinion.
	Represents lesser level of use based on professional opinion.
	shaded cells represent information based on field data & direct knowledge
	red cells represent critical periods when flow fluctuations should be avoided to prevent disruption of spawning, to minimize disturbance of eggs during early incubation, and to minimize stranding or displacing newly emerged fry

McKenzie Population

The McKenzie River population of UWR Chinook salmon could be affected by the proposed action. Prior to the construction of major dams in the Willamette River basin, the McKenzie River produced about 40% of the Chinook salmon spawning upstream of Willamette Falls (Howell et al. 1988). Historical spawning areas for UWR Chinook salmon within the upper McKenzie subbasin included the mainstem McKenzie and South Fork McKenzie Rivers, Smith River, Lost Creek, Horse Creek, Blue River, and Gate Creek (Mattson 1948, Parkhurst et al. 1950). Habitat that remained suitable for, and available to, these fish in the 1940s was estimated to have the capacity to support about 80,000 spawners (Parkhurst et al. 1950). However, adult runs this large were never documented. The Oregon Fish Commission estimated the largest run of UWR Chinook salmon into the McKenzie River subbasin for which it had data was about

46,000 adults⁵ in 1941 (Howell et al.1985). This estimate was based on an assumption that 39 percent of the UWR Chinook salmon adults passing over Willamette Falls were bound for the McKenzie subbasin (Mattson 1948, USACE 1995). Estimated run sizes of UWR Chinook salmon returning to the McKenzie subbasin from 1945-1960 averaged 18,000 adults (USACE 1995).

While the overall extinction risk for the McKenzie River population is considered low, its population viability trend is decreasing (NWFSC 2015). In more recent years, McKenzie River Chinook salmon escapements have accounted for 11–23% of the Willamette River basin escapement, although the proportion of naturally produced fish spawning upstream of Leaburg Dam increased from 68% in 2001 to 84% in 2007 (Schroeder et al. 2007). The abundance of natural origin McKenzie River spring-run Chinook salmon has recently declined to levels not seen since the time of listing (Figure 2.2-6). Since 2014 adult counts at Leaburg Dam have remained low, ranging from 1,904 to 3,006 adults passing the dam each year between 2015 and 2017 (ODFW 2018b). This decline in the McKenzie River population is a source of concern for the entire UWR Chinook salmon ESU given that this population was previously seen as a stronghold of natural production (NWFSC 2015).

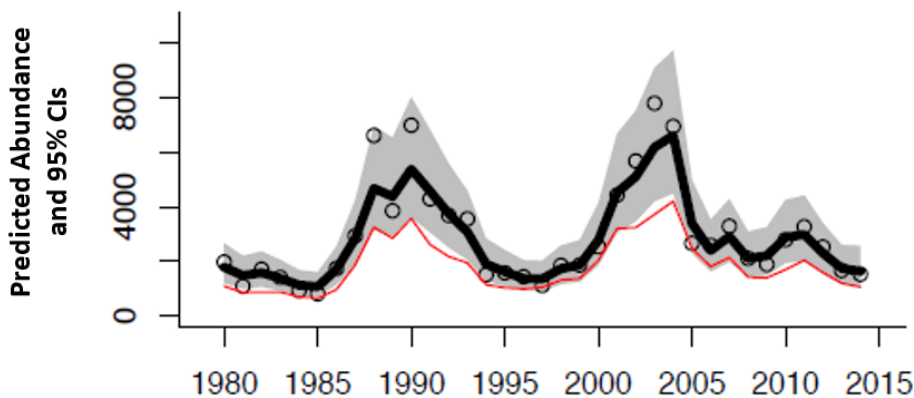


Figure 2.2-6 Estimated total (thick black line) and natural origin (thin red line) smoothed trends of McKenzie River Chinook salmon spawner abundance. Grey band indicates 95% confidence intervals of estimated total abundance, and points show the annual raw spawning abundance estimates. Data reflect counts at Leaburg and Cougar Dams. Reproduced from NWFSC (2015).

Key limiting factors and threats for the McKenzie River subbasin population include a variety of dam effects, a large mitigation hatchery program developed partly to help offset dam effects, and the cumulative effects of multiple land and water use practices on aquatic habitat (ODFW and NMFS 2011), all of which are relevant to the action area. Dams that have lacked effective passage facilities have prevented natural-origin fish from using historically important habitats in upper portions of the McKenzie subbasin, including above Trail Bridge Dam. ODFW (2005) estimates that 16% of the population's historical habitat has been blocked by dams, including the

⁵ NMFS considers the estimates in this paragraph to represent natural-origin fish. Although hatcheries began operating in the Willamette basin in the early 1900s, production was small. Few adults were thought to have returned from hatchery releases made before the 1960s due to poor hatchery practices (Howell et al. 1985)

Carmen-Smith Project. The current population decline is despite the restoration of access to spawning and rearing habitat above Cougar Dam on the South Fork McKenzie River through a trap and haul program and installation of a temperature control structure at Cougar Dam in 2008. While poor downstream passage of juveniles at Cougar Dam appears to be limiting productivity from the South Fork McKenzie, redd counts for the entire McKenzie River have declined over 2010-2014, which suggests a more systemic limiting factor is contributing to the short- and long-term negative population trends for UWR Chinook salmon in this subbasin (NWFSC 2015).

Pre-spawn mortality (PSM) is a concern for this population, although spawner surveys indicate PSM is much lower in the reaches above Leaburg Dam (0 and 5%) than in the reaches below (17 and 35%) (Sharpe et al. 2017). These recent findings are consistent with trends and ranges observed in similar previous studies conducted since 2001 (Schroeder et al. 2007).

Table 2.2-5 Periodicity table for UWR Chinook salmon in the South Fork McKenzie River below Cougar Dam. From the Willamette Fish Operations Plan (USACE 2018d)

Life Stage/Activity/Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upstream Adult Migration												
Adult Spawning												
Adult Holding												
Egg Incubation through Fry Emergence												
Juvenile Rearing												
All life stages												
Fry												
Subyearling												
Fall migrant												
Yearling												
Downstream Juvenile Migration												
Dec-May = fry												
April-mid July = subyearling												
mid-Oct-Dec = fall migrants												
mid Feb-mid Jun = yearling smolts												
<div> <div></div> Represents periods of peak use based on professional opinion. <div></div> Represents lesser level of use based on professional opinion. <div></div> shaded cells represent information based on field data & direct knowledge <div></div> red cells represent critical periods when flow fluctuations should be avoided to prevent disruption of spawning, to minimize disturbance of eggs during early incubation, and to minimize stranding or displacing newly emerged fry </div>												

Middle Fork Willamette Population

Chinook salmon in the Middle Fork Willamette River are monitored through redd and carcass surveys throughout much of the basin. In addition, fish are enumerated at both the Dexter Trap and at the Fall Creek trap below Fall Creek Dam. Presently, unmarked fish (presumed naturally produced) are transported above Fall Creek Dam. Only marked hatchery-origin fish are currently transported above Dexter Dam. Although the transported hatchery-origin adults successfully reproduce, in the absence of adequate downstream juvenile fish passage facilities it is unlikely that this program currently provides any substantial direct benefit to population abundance or productivity. Alternatively, the progeny of fish passed above Fall Creek Dam have a much higher likelihood of successful downstream passage via the complete drawdown of Fall Creek Reservoir every fall. Based on returns to Fall Creek Dam, adult-to-adult return rates⁶ have averaged 0.97 from 2010-2014 (NWFSC 2015).

With the exception of spawning reaches above Fall Creek Dam, the remainder of the currently accessible portion of the Middle Fork Willamette Basin, below Dexter Dam and Fall Creek Dam, is subject to conditions that result in a very high pre-spawning mortality and very poor incubation and juvenile survival. Natural-origin spawners above Fall Creek averaged 138 \pm 40 fish from 2002-2014, with a slightly positive long-term trend (NWFSC 2015). Estimates of pre-spawning mortality can be quite high in some years for the fish transported above Fall Creek Dam. Of the hatchery-origin adults transported above Dexter Dam, prespawning mortalities have been high for fish transported to Hills Creek above Hills Creek Dam (49.3% 2012-14) compared to the North Fork Middle Fork Willamette River (39.0%, 2012-2014) (NWFSC 2015). Longer transportation times to Hills Creek are thought to be partially responsible for these differences (Naughton *et al.* 2014).

⁶Adult-to-adult rates calculated as NOR adults returning to Fall Creek Dam divided by the average number of adults (NOR and HOR) passed above Fall Creek Dam four and five years previously.

Table 2.2-6 Periodicity table for UWR Chinook salmon in the Middle Fork Willamette River below Dexter Dam. From the Willamette Fish Operations Plan (USACE 2018d)

Life Stage/Activity/Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upstream Adult Migration												
Adult Spawning												
Adult Holding												
Egg Incubation through Fry Emergence												
Juvenile Rearing												
All life stages												
Fry												
Subyearling												
Fall migrant												
Yearling												
Downstream Juvenile Migration												
Dec-Mar = fry												
April-mid July = subyearling												
mid-Oct-mid Dec = fall migrants												
Mar-May = yearling smolts;												
<div> <div></div> Represents periods of peak use based on professional opinion. <div></div> Represents lesser level of use based on professional opinion. <div></div> shaded cells represent information based on field data & direct knowledge <div></div> red cells represent critical periods when flow fluctuations should be avoided to prevent disruption of spawning, to minimize disturbance of eggs during early incubation, and to minimize stranding or displacing newly emerged fry </div>												

UWR Steelhead

The UWR steelhead distinct population segment (DPS) includes all naturally spawned anadromous winter-run steelhead populations in the Willamette River, Oregon, and its tributaries upstream from Willamette Falls to the Calapooia River (inclusive). There are no hatchery programs included in this DPS since the last winter-run hatchery fish were outplanted in 1998. The hatchery summer-run steelhead that occur in the Willamette Basin are an out-of-basin stock and not considered part of the DPS.

The Willamette/Lower Columbia Technical Recovery Team identified four historical independent populations within this DPS, all of which are part of one major population group. These are the Molalla, the North and South Santiams and the Calapooia (Figure 2.2.-7). Both North and South Santiam populations were designated core and genetic legacy populations. Core populations historically represented the centers of abundance and productivity for a major population group. Genetic legacy populations have had minimal influence from non-endemic fish due to artificial propagation activities or exhibit important life history characteristics no longer found throughout the ESU (WLCTRT 2003).

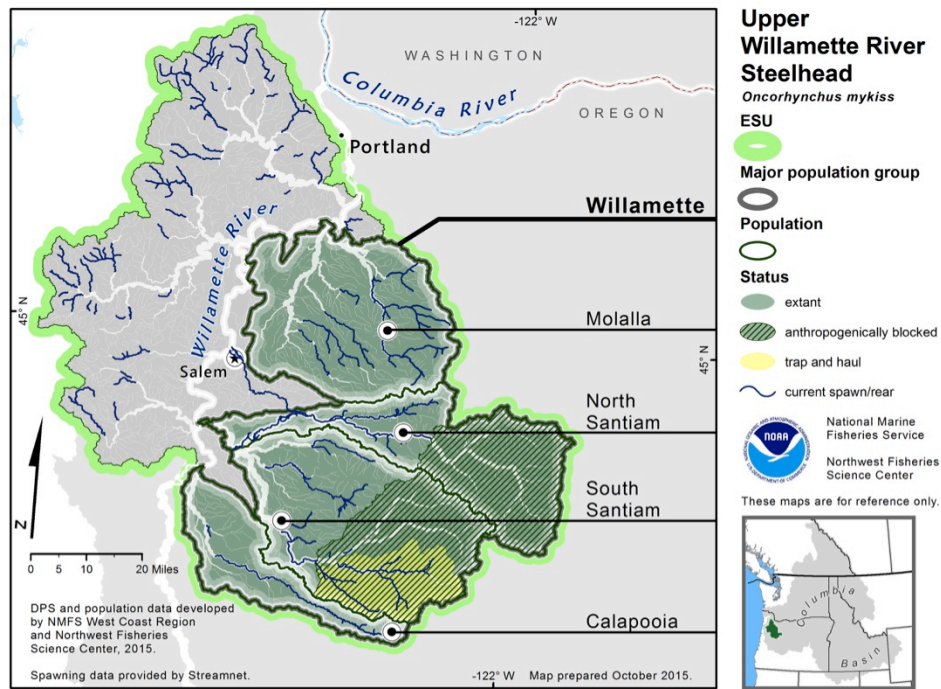


Figure 2.2-7 Map of the Willamette River winter steelhead DPS's spawning and rearing areas, illustrating populations and major population groups (NWFSC 2015). The west-side tributaries do not have demographically independent populations but are included because of their importance to the DPS as a whole (Myers et al. 2006).

Although spawning winter steelhead have been reported in the west-side tributaries to the Willamette River, these tributaries are not considered to have constituted an independent population historically (Myers et al. 2006). These tributaries may, however, serve as a population sink for the DPS, meaning that, although they do not sustain (and are not believed to have historically sustained) an independent population, winter steelhead may intermittently utilize them for spawning or rearing.

Populations in this DPS have experienced long-term declines in spawner abundance (Figure 2.2-8). UWR steelhead as counted at Willamette Falls were at a relatively steady but low abundance at the time of the last status review (NWFSC 2015). From 2007-2016, winter steelhead spawners upstream of Willamette Falls as estimated from spawning surveys were even lower, ranging from 1,315 to 4,304 with an average of 3,140 spawners (NMFS 2019). Since then counts of adult UWR steelhead at Willamette Falls have continued decline to lowest numbers ever counted, with 2017 and 2018 counts reaching only 15-30% of the 5-year geometric mean calculated for 2010-2014 (Table 2.2-7). The underlying cause(s) of these declines is not well understood, as returning winter steelhead do not experience the same deleterious water temperatures as the spring-run UWR Chinook salmon. Improvements to Bennett Dam fish passage and operational temperature control at Detroit Dam may be providing some stability in abundance in the North Santiam River population.

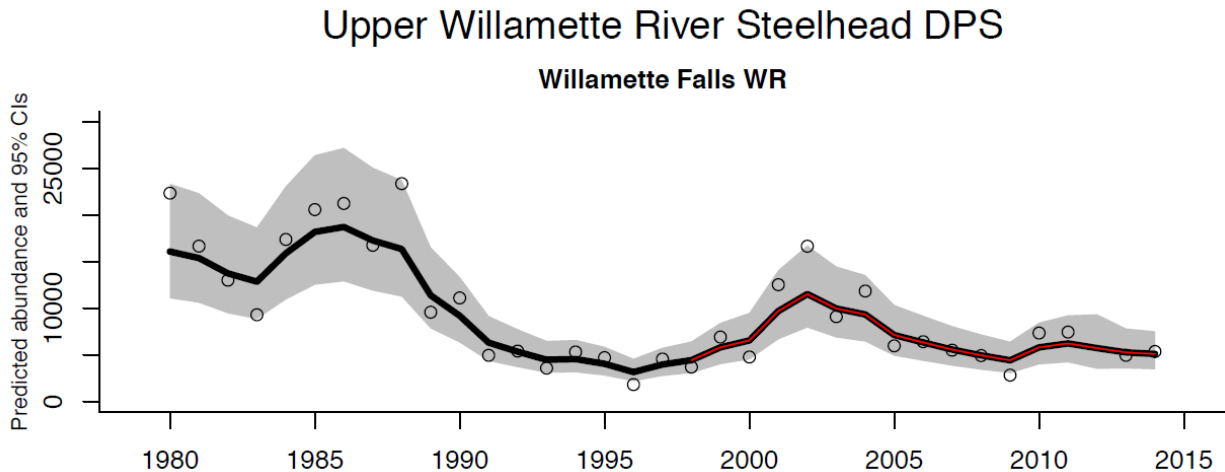


Figure 2.2-8 Smoothed trend in estimated total (thick black line), and naturally produced (thin red line) Willamette Falls counts and population spawning abundance of UWR steelhead (NWFSC 2015). Points show the annual raw spawning abundance estimates.

Table 2.2-7 UWR Steelhead adult abundance at Willamette Falls. The 5-year geometric mean of Willamette Falls counts from 2010-2014 was calculated at the time of the last status review (NWFSC 2015). Counts for later years were obtained from the Willamette Falls annual fish counts (ODFW 2018b).

Year	Total Natural Origin Adults
2010-2014 (5-year geometric mean)	6,164
2015	4,508
2016	5,778
2017	822
2018	1,829

Pinniped predation at Willamette Falls has recently been identified as a potential cause for recent declines in UWR abundance. While increasing numbers of California sea lions were observed in the Willamette River in the mid-1990s, monitoring at Willamette Falls between 1995 and 2003 showed that typically fewer than a dozen sea lions came to the falls during a given year and predation losses were typically low. Since then numbers of California and Stellar sea lions have increased at Willamette Falls, and ODFW resumed predation monitoring in 2014. ODFW estimated that the numbers of winter steelhead killed by sea lions in 2014, 2015, 2016, and 2017 was 780, 557, 915, and 270 respectively (ODFW 2018a). Falcy (2017) used population viability analysis (PVA) to estimate the effects of sea lion predation on the four independent populations of winter-run steelhead upstream of Willamette Falls. He found that the probability of extinction over 100 years rose with sea lion predation rate for all four populations in the DPS, and rose from less than 5% to 60% or higher for both Santiam UWR steelhead populations when comparing conditions with no sea lions to predation rates observed in 2017 (Falcy 2017). ODFW has since applied for and received a permit from NMFS under the MMPA to remove California sea lions identified as preying on ESA-listed fish at Willamette Falls, and has been actively

removing sea lions under this permit since December 2018 to reduce predation on UWR steelhead.

Winter-run steelhead enter the Willamette River beginning in November or December but do not ascend to their spawning areas until late March or April. Spawning takes place from April to early June (Myers et al. 2006). UWR steelhead may spawn more than once, although the frequency of repeat spawning is relatively low. Repeat spawners are predominantly females and usually spend one-year post spawning in the ocean and spawn again the following spring.

Juvenile steelhead rear in headwater tributaries and upper portions of the subbasins for one to four years (most often two years), then as smoltification proceeds in April through May, migrate quickly downstream through the mainstem Willamette River and Columbia River estuary and into the ocean. There is currently insufficient data to adequately characterize residence time of juvenile UWR steelhead in these reaches and we assume rearing juveniles could be present in any of the reaches downstream of WVS dams in the action area. Long-term beach seine surveys conducted by ODFW in the Willamette River and lower reaches of spawning tributaries targeting juvenile Chinook salmon habitat incidentally captured small numbers of UWR steelhead smolts in all areas sampled, including the mainstem mid-Willamette River, with steelhead captures peaking in May (Whitman et al. 2017). UWR steelhead typically forage in the ocean for one to four years (most often two years) and during this time are thought to migrate north to Canada and Alaska and into the North Pacific including the Alaska Gyre (Myers et al. 2006). Life history timing of each stage for the North and South Santiam populations are shown in Tables 2.2-8 and 2.2-9, below.

Overall Status of DPS

In the latest status review of the UWR winter steelhead DPS, the risk ratings stayed the same as the previous status review, but the measurements of the VSP scores showed that there is some decline in the scores (Figure 2.2-9). As stated by NWFSC (2015):

While the diversity goals are partially achieved through the closure of winter-run steelhead hatchery programs in the Upper Willamette River, there is some concern that the summer-run steelhead releases in the South Santiam River may be influencing the viability of native steelhead in the North and South Santiam rivers. Overall, none of the populations in the DPS are meeting their recovery goals...

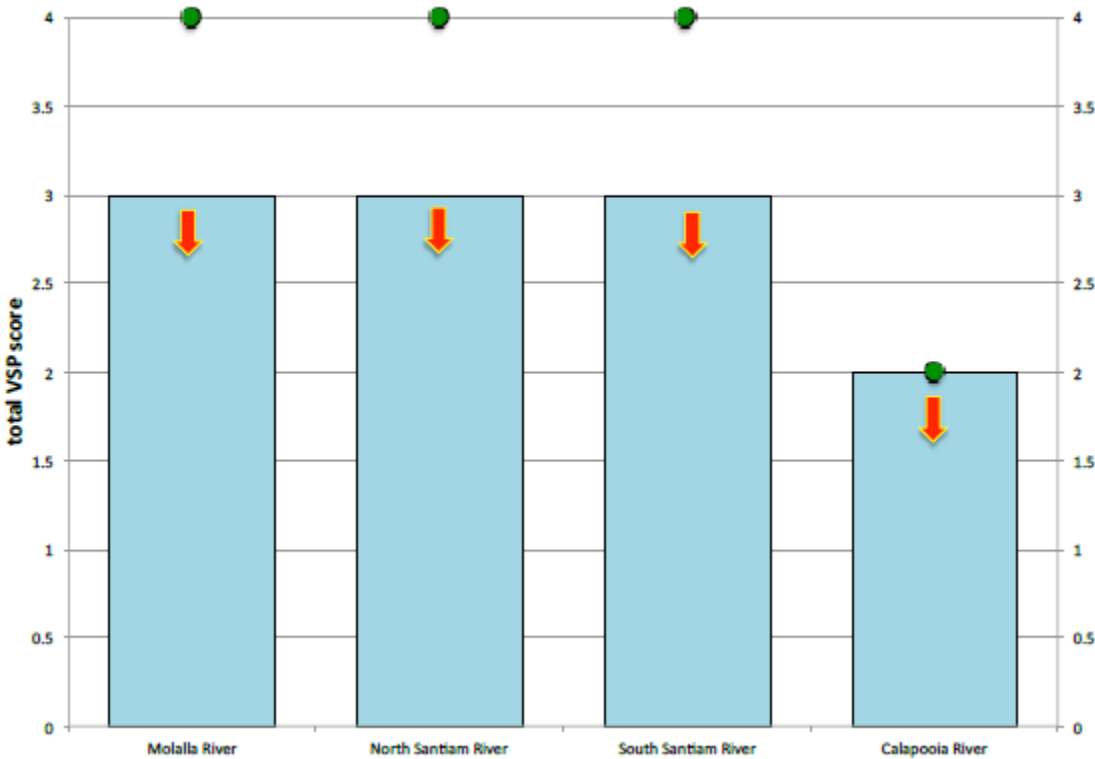


Figure 2.2-9 VSP status of demographically independent populations in the Upper Willamette winter-run steelhead DPS. Green circles show recovery goal. Blue bars show previous VSP status. Red and green arrows show general direction of current status. Figure taken from NWFSC (2015).

Current Limiting Factors

The ESA recovery plan (ODFW and NMFS 2011) identifies the current limiting factors for this DPS:

- Degraded freshwater habitat, including floodplain connectivity and function, channel structure and complexity, incubation gravels, riparian areas, and gravel and large wood recruitment
- Degraded water quality including elevated water temperature and toxins
- Increased disease incidence
- Altered stream flows
- Reduced access to spawning and rearing habitats due to migration barriers and impaired fish passage at dams
- Altered food web due to changes in inputs of microdetritus
- Predation by native and non-native species, including hatchery fish and pinnipeds
- Competition related to introduced races of salmon and steelhead
- Altered population traits due to natural origin fish interbreeding with hatchery origin fish.

In summary, habitat loss and degradation associated with the Federal dams is currently limiting production in the North Santiam and South Santiam populations. For the Molalla and Calapooia

populations, habitat loss and degradation associated with land management and urbanization is currently the most pressing limiting factors/threats. There are no hatchery programs for winter steelhead, but hatchery summer steelhead pose risks to listed winter steelhead from hybridization and ecological interactions. Predation in the reservoirs, mainstem Willamette River, Willamette Falls, lower Columbia River and estuary by non-native fish species, marine mammals, Caspian terns and cormorants predate upon both adult and juvenile steelhead at high levels.

North Santiam Population

In the North Santiam River basin, adult returns of UWR steelhead in the North Santiam have also been declining, particularly in the past five years (Figure 2.2-10). The population is the most crucial one in the basin, tracking the changing counts at Willamette Falls, where in recent years the mainstem Willamette River counts dropped to 16-33% of the 10-year average. North Santiam counts at the Upper and Lower Bennett Dam ladders show this population comprises 14-21% of all winter steelhead passing Willamette Falls. Recent adult counts at the Upper and Lower Bennett Dams near Geren Island have dropped from a recent high of 829 in 2015 to 390 in 2018, with an extreme low of 160 in 2017.

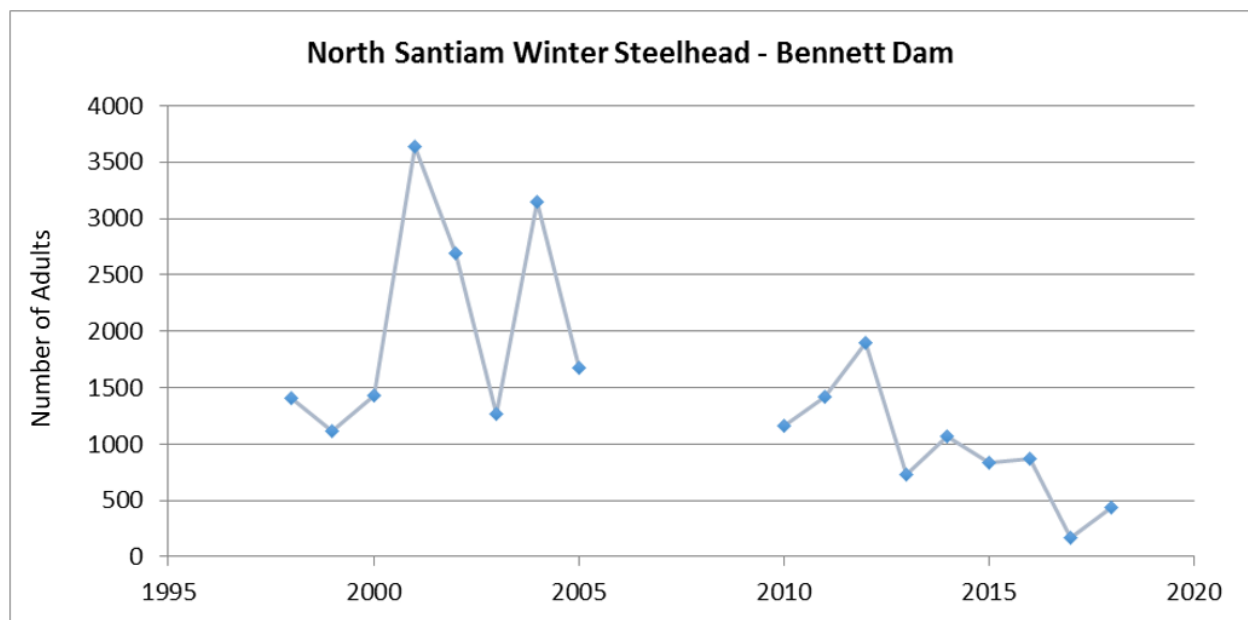


Figure 2.2-10 Counts of adult winter steelhead counted at Bennett Dam. Data from ODFW (2018b).

South Santiam Population

In the South Santiam River basin there is not a downstream location where counts of fish entering the tributary are readily available, and therefore estimates of adults below Foster dam are based on spawning surveys. Estimates of UWR steelhead spawners in the South Santiam have ranged from 81 to 5,805, averaging 1,559 between 1985 and 2016, and from 81 to 1,314, averaging 870 in the last ten years (NMFS 2019). At Foster Fish Facility the numbers of

returning adult winter steelhead have been declining steadily since 2010, with numbers dropping from over 400 in 2010 to only 18 adults collected in 2017 and 30 collected in 2018 (Figure 2.2-11).

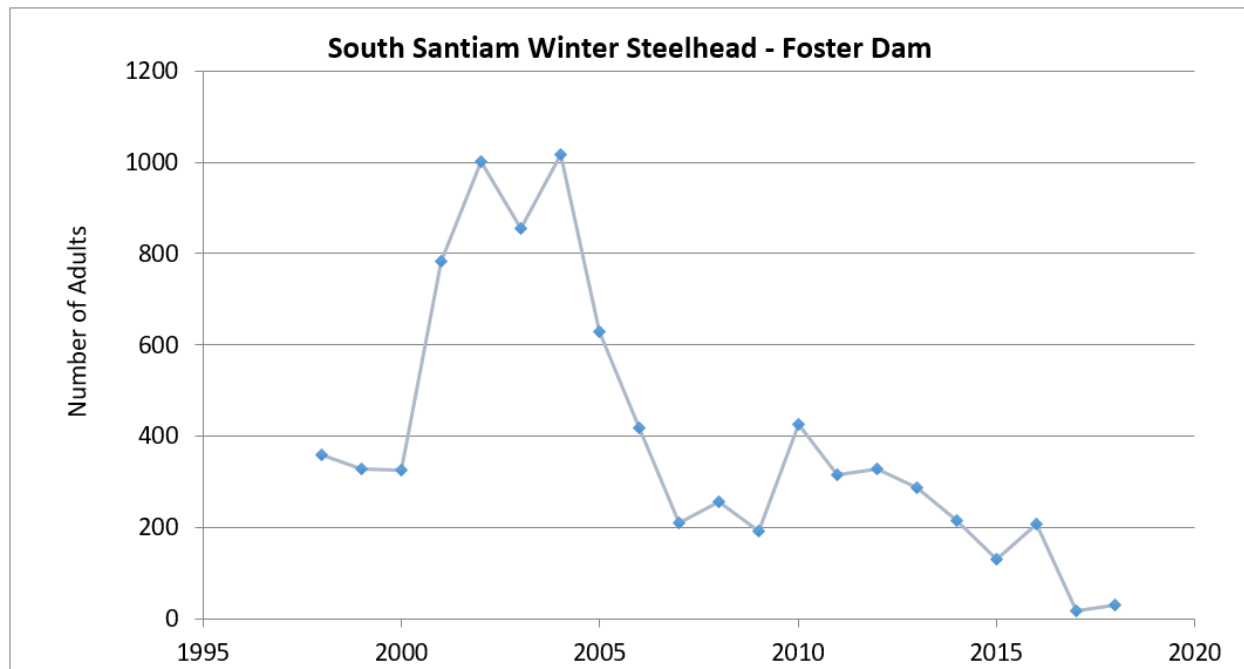






Figure 2.2-11 Counts of adult winter steelhead counted at Foster Adult Fish Facility. Data from ODFW (2018b).

Table 2.2-8 Periodicity table for winter steelhead in the North Santiam River below Big Cliff Dam. From the Willamette Fish Operations Plan (USACE 2018d).

[illegible]

Table 2.2-9 Periodicity table for winter steelhead in the South Santiam River below Foster Dam. From the Willamette Fish Operations Plan (USACE 2018d).

Life Stage/Activity/Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upstream Adult Migration	Peak	Lesser			Lesser	Lesser						
Adult Holding	Lesser				Lesser	Lesser						
Adult Spawning			Lesser	Lesser	Lesser	Lesser	Lesser	Lesser				
Egg Incubation through Fry Emergence			Lesser	Critical	Critical	Critical	Lesser	Lesser				
Juvenile Rearing	Lesser	Lesser	Lesser	Lesser	Lesser	Lesser	Lesser	Lesser	Lesser	Lesser	Lesser	Lesser
Downstream Juvenile Migration	Lesser	Lesser	Lesser	Critical	Critical	Critical	Lesser	Lesser	Lesser	Lesser	Lesser	Lesser

 Represents periods of peak use based on professional opinion
 Represents lesser level of use based on professional opinion
 Represents information based on field data & direct knowledge
 Represents critical periods when flow fluctuations should be avoided to prevent disruption of spawning, to minimize disturbance of eggs during early incubation, and to minimize stranding or displacing newly emerged fry

2.2.2 Status of the Critical Habitat

This section describes the status of designated critical habitat affected by the proposed action by examining the condition and trends of the essential physical and biological features of that habitat throughout the designated areas. These features are essential to the conservation of the ESA-listed species because they support one or more of the species' life stages (*e.g.*, sites with conditions that support spawning, rearing, migration and foraging).

For most salmon and steelhead, NMFS's critical habitat analytical review teams (CHARTs) ranked watersheds within designated critical habitat at the scale of the fifth-field hydrologic unit code (HUC5) in terms of the conservation value they provide to each ESA-listed species that they support (NMFS 2005). The conservation rankings were high, medium, or low. To determine the conservation value of each watershed to species viability, the CHARTs evaluated the quantity and quality of habitat features, the relationship of the area compared to other areas within the species' range, and the significance to the species of the population occupying that area. Even if a location had poor habitat quality, it could be ranked with a high conservation value if it were essential due to factors such as limited availability, a unique contribution of the population it served, or is serving another important role.

A summary of the status of critical habitats, considered in this opinion, is provided in Table 2.2-10, below.

Table 2.2-10 Critical habitat, designation date, federal register citation, and status summary for critical habitat considered in this opinion.

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Lower Columbia River Chinook salmon	9/02/05 70 FR 52630	Critical habitat encompasses 10 subbasins in Oregon and Washington containing 47 occupied watersheds, as well as the lower Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some, or high potential for improvement. We rated conservation value of HUC5 watersheds as high for 30 watersheds, medium for 13 watersheds, and low for four watersheds.
Upper Columbia River spring-run Chinook salmon	9/02/05 70 FR 52630	Critical habitat encompasses four subbasins in Washington containing 15 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some, or high, potential for improvement. We rated conservation value of HUC5 watersheds as high for 10 watersheds, and medium for five watersheds. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Snake River spring/summer-run Chinook salmon	10/25/99 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers, and all tributaries of the Snake and Salmon rivers (except the Clearwater River) presently or historically accessible to this ESU (except reaches above impassable natural falls and Hells Canyon Dam). Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Upper Willamette River Chinook salmon	9/02/05 70 FR 52630	Critical habitat encompasses 10 subbasins in Oregon containing 56 occupied watersheds, as well as the lower Willamette/Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some, or high, potential for improvement. Watersheds are in good to excellent condition with no potential for improvement only in the upper McKenzie River and its tributaries (NMFS 2005). We rated conservation value of HUC5 watersheds as high for 22 watersheds, medium for 16 watersheds, and low for 18 watersheds.
Snake River fall-run Chinook salmon	10/25/99 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers, and all tributaries of the Snake and Salmon rivers presently or historically accessible to this ESU (except reaches above impassable natural falls, and Dworshak and Hells Canyon dams). Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Columbia River chum salmon	9/02/05 70 FR 52630	Critical habitat encompasses six subbasins in Oregon and Washington containing 19 occupied watersheds, as well as the lower Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 16 watersheds, and medium for three watersheds.

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Lower Columbia River coho salmon	2/24/16 81 FR 9252	Critical habitat encompasses 10 subbasins in Oregon and Washington containing 55 occupied watersheds, as well as the lower Columbia River and estuary rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 34 watersheds, medium for 18 watersheds, and low for three watersheds.
Snake River sockeye salmon	10/25/99 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers; Alturas Lake Creek; Valley Creek; and Stanley, Redfish, Yellow Belly, Pettit and Alturas lakes (including their inlet and outlet creeks). Water quality in all five lakes generally is adequate for juvenile sockeye salmon, although zooplankton numbers vary considerably. Some reaches of the Salmon River and tributaries exhibit temporary elevated water temperatures and sediment loads that could restrict sockeye salmon production and survival (NMFS 2015b). Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Upper Columbia River steelhead	9/02/05 70 FR 52630	Critical habitat encompasses 10 subbasins in Washington containing 31 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 20 watersheds, medium for eight watersheds, and low for three watersheds.
Lower Columbia River steelhead	9/02/05 70 FR 52630	Critical habitat encompasses nine subbasins in Oregon and Washington containing 41 occupied watersheds, as well as the lower Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 28 watersheds, medium for 11 watersheds, and low for two watersheds.
Upper Willamette River steelhead	9/02/05 70 FR 52630	Critical habitat encompasses seven subbasins in Oregon containing 34 occupied watersheds, as well as the lower Willamette/Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 25 watersheds, medium for 6 watersheds, and low for 3 watersheds.
Middle Columbia River steelhead	9/02/05 70 FR 52630	Critical habitat encompasses 15 subbasins in Oregon and Washington containing 111 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of occupied HUC5 watersheds as high for 80 watersheds, medium for 24 watersheds, and low for 9 watersheds.
Snake River basin steelhead	9/02/05 70 FR 52630	Critical habitat encompasses 25 subbasins in Oregon, Washington, and Idaho. Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.

Status of UWR Species Critical Habitat

Land management activities have degraded stream habitat conditions in the Willamette River mainstem above Willamette Falls and in associated subbasins. In the Willamette River mainstem and lower sub-basin mainstem reaches, high density urban development and widespread agricultural effects have reduced aquatic and riparian habitat quality and complexity, and altered sediment and water quality and quantity, and watershed processes. The Willamette River, once a highly braided river system, has been dramatically simplified through channelization, dredging, and other activities that have reduced rearing habitat by as much as 75%. In addition, the construction of 37 dams in the basin blocked access to more than 435 miles of stream and river spawning habitat. The dams alter the temperature regime of the Willamette River and its tributaries, affecting the timing and development of naturally-spawned eggs and fry. Logging in the Cascade and Coast Ranges, and agriculture, urbanization, and gravel mining on valley floors have contributed to increased erosion and sediment loads throughout the basin.

The mainstem Willamette River has been channelized and stripped of large wood. Development began to encroach on the riparian forest beginning in the 1870s (Sedell and Froggatt 1984). The total area of river channels and islands in the Willamette River decreased from 41,000 to 23,000 acres, and the total length of all channels decreased from 355 miles to 264 miles, between 1895 and 1995 (Gregory *et al.* 2002a). They noted that the lower reach, from the mouth of the river to Newberg (RM 50), is confined within a basaltic trench, and that due to this geomorphic constraint, less channel area has been lost than in upstream areas. The middle reach from Newberg to Albany (RM 50 to 120) incurred losses of 12% of primary channel area, 16% of side channels, 33% of alcoves, and 9% of island area. Even greater changes occurred in the upper reach, from Albany to Eugene (RM 187). There, approximately 40% of both channel length and channel area were lost, along with 21% of the primary channel, 41% of side channels, 74% of alcoves, and 80% of island areas.

The banks of the Willamette River have more than 96 miles of revetments; approximately half were constructed by the Corps. Generally, the revetments were placed in the vicinity of roads or on the outside bank of river bends, so that while only 26% of the total length is revetted, 65% of the meander bends are revetted (Gregory *et al.* 2002b). The majority of dynamic sections have been armored, reducing adjustments in channel bed and sediment storage by the river, and thereby diminishing both the complexity and productivity of aquatic habitats (Gregory *et al.* 2002b).

Riparian forests have diminished considerably in the lower reaches of the Willamette River (Gregory *et al.* 2002c). Sedell and Froggatt (1984) noted that agriculture and cutting of streamside trees were major agents of change for riparian vegetation, along with snagging of large wood in the channel. The reduced shoreline, fewer and smaller snags, and reduced riparian forest comprise large functional losses to the river, reducing structural features, inputs of wood and litter, shade, entrained allochthonous materials, and flood flow filtering capacity. Extensive changes began before the major dams were built, with navigational and agricultural demands dominating the early use of the river. The once expansive forests of the Willamette River floodplain provided valuable nutrients and organic matter during flood pulses, food sources for

macroinvertebrates, and slow-water refugia for fish during flood events. These forests also cooled river temperatures as the river flowed through its many channels.

Hyporheic flow in the Willamette River has been examined through discharge measurements and is significant in some areas, particularly those with gravel deposits (Wentz *et al.* 1998; Fernald *et al.* 2001). The loss of channel complexity and meandering that fosters creations of gravel deposits decreases the potential for hyporheic flows, as does gravel mining. Hyporheic flow processes water and affects its quality on reemerging into the main channel, stabilizing variations in physical and chemical water characteristics. Hyporheic flow is important for ecological functions, some aspects of water quality (such as temperature and dissolved oxygen), and some benthic invertebrate life stages. Alcove habitat, which has been limited by channelization, combines low hydraulic stress and high food availability with the potential for hyporheic flows across the steep hydraulic gradients in the gravel separating them from the main channel (Fernald *et al.* 2001).

This critical habitat contains sites or components providing PBFs supporting one or more Chinook salmon life stages, including (NMFS 2005):

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development;
- Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks; and
- Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.

Specific geographic areas of concern for UWR Chinook salmon and steelhead identified in the most recent status review (NMFS 2016a) include dams and reservoirs in the four historically most productive tributaries, which are the North Santiam, South Santiam, McKenzie and Middle Fork Willamette populations. The importance of these populations to recovery of the ESU as a whole is described in Section 2.2.1, above. The status review also identified highly developed in-stream and riparian reaches in the mainstem Willamette River where shallow water and floodplain habitat has been lost or degraded as areas of concern, particularly below Willamette Falls and in the Portland Harbor (NMFS 2016a).

A number of restoration and protection actions have been implemented in freshwater and estuary habitat throughout the range of UWR Chinook salmon and steelhead. However, at this point there is not yet information demonstrating that improvements in habitat conditions have led to improvements in population viability (NMFS 2016a). A lack of access to historical spawning and rearing areas caused by dams in the east-side tributaries will, in the absence of effective passage programs, continue to confine UWR species to lower tributary and mainstream reaches which generally have higher temperatures and poorer water quality, and are more impacted by land

development (NWFSC 2015). Degraded habitat conditions throughout the range of the UWR Chinook salmon ESU and UWR steelhead DPS continue to be a concern, particularly with regard to land use activities that affect the quality and accessibility of suitable habitat as well as habitat-forming processes (NMFS 2016a).

The potential effects of climate change on this critical habitat are consistent with those discussed earlier in this section, as well as in Section 2.4, below.

2.3 Action Area

“Action area” means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02).

The action area includes the 13 WVS reservoirs and riverine reaches downstream of the WVS dams in the Willamette Basin to the confluence with the Columbia River. The proposed action would change operation of the WVS dams and reservoirs, which would directly impact areas inundated by the reservoirs as well as instream flows and flow-related water quality parameters below the WVS dams to the confluence of the Willamette River with the Columbia River. Downstream from the confluence of the Willamette and Columbia Rivers, any impacts from the proposed action would become so attenuated they would not be able to be meaningfully evaluated.

2.4 Environmental Baseline

The “environmental baseline” includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02).

Over the last 150 years UWR Chinook salmon and UWR steelhead have been adversely affected by dams, habitat degradation, fishing, and interactions with hatchery-origin fish. The many challenges facing species in the Willamette Basin have been described at length in previous biological opinions (e.g., 2008 WVS BiOp NWR-2000-02117; Willamette Water supply, WCR-2018-9781; EPA Oregon Water Quality Standards 2015, WCR-2013-76; FEMA 2017, NWR-2011-3197). The Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead (ODFW and NMFS, 2011) discusses the key limiting factors for UWR Chinook and steelhead populations in the Willamette Basin in great detail. The Recovery Plan for Lower Columbia River (LCR) Coho Salmon, Chinook Salmon, and Steelhead, and Columbia River Chum has information on these species in the lower Willamette River (NMFS 2013).

As described in the 2008 BiOp on the WVS (NMFS 2008a), the environmental baseline in the action area continues to be affected by the past and present operation and existence of dams, which block habitat access, alter downstream flows and water quality, eliminate transport of sediment and wood, and inundate riverine habitat. Downstream, habitat is further degraded by water diversions, agricultural and urban run-off, channel hardening and floodplain disconnection.

We first discuss those limiting factors of highest priority for this analysis, which are those related to potential effects of the proposed action having the greatest impact on limiting the potential for species recovery. The proposed action has the potential to alter water quantity and water quality conditions below WVS dams and reservoirs, and therefore baseline conditions of these attributes are discussed in greatest detail.

2.4.1 Water Quantity

Flows in the Willamette Basin have been greatly altered by the construction and operation of dams. With the exception of a few run-of-river projects, dams are typically “high-head” projects which are intended to capture and hold flow to release at desired times, as opposed to discharging outflow at the same rate inflows are received. Since the completion of WVS flood control dams the range of peak flows in the mainstem Willamette River are greatly reduced compared to pre-dam conditions (Figure 2.4-1).

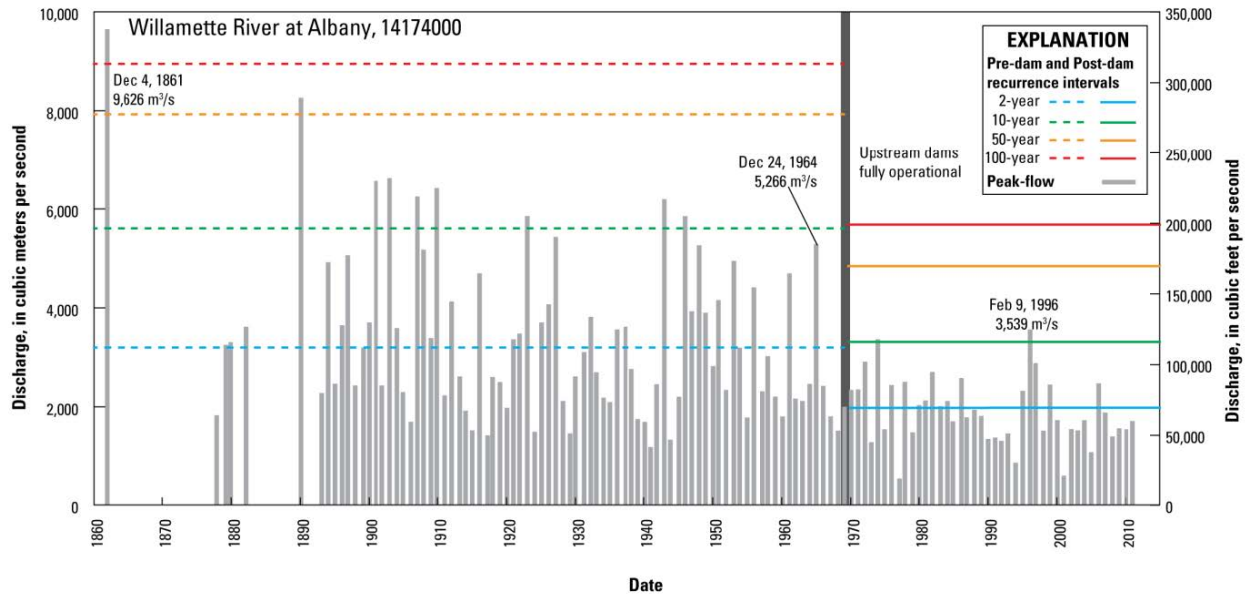


Figure 2.4-1 Graph showing peak annual discharge for U.S. Geological Survey streamflow-gaging station Willamette River at Albany, Oregon. Figure 18 from Wallick et al. 2013.

As described in Section 1 (Introduction), WVS reservoirs are typically drained in the winter to capture and safely release flows from large storm events, but are allowed to fill in the spring so that stored water can be used for a variety of authorized purposes. One of these purposes is to maintain downstream navigation and water quality. The authorizing document for the WVS, HD 531 (81st Congress, March 20, 1950) stipulated the minimum flow of 5,000 cfs between Albany and the Santiam River, and 6,500 cfs downstream to Salem to allow open-river navigation from Portland to Corvallis. HD 531 also recognized that these flows would reduce pollution concentrations in the river, and would make oxygen available for fish life. During consultation on the 2008 BiOp, flow objectives for April through June were adopted and incorporated into the flow objectives finalized in the RPA for the benefit of fish migration. Together with flows authorized by HD 531 this resulted in a series of mainstem flow objectives from April through

October, and the Action Agencies currently operate the WVS to make every effort to meet or exceed these objectives (USACE 2007, Table 3-2). Mainstem flow minimum objectives measured at Salem and Albany in years that are not adequate or abundant water storage years are reduced, following the framework described in Appendix D of the Supplementary BA (USACE 2007).

Recently minimum flow targets have not been met in all years, both in the mainstem and in tributary reaches below dams. In the 10 years after the 2008 RPA, from 2009 to 2018, five years, or 50%, were classified as adequate at the start of the conservation season. In three of the five adequate years, the flow releases were below the Salem targets. The days missed were from one-third in June 2013 and 2018 to as many as all of June 2016, and approximately half of May in 2013 and 2016. The period of record used for Corps modeling, 1938-2008, classified only 17.5% of the years as adequate (USACE 2018b, Appendices). However, the most recent 50 years had approximately twice as many years classified as adequate (36.4%) than the period of record, indicating a shift towards fewer abundant and more adequate storage years. Given the record of Salem flow targets being missed in May and June of adequate years since 2008, it is likely that minimum flows in the Willamette River will continue to be below minimum flow targets more often than expected at the time of the 2008 BiOp.

By seasonally putting water into storage and releasing it later in the year, the large water storage facilities of the Willamette Project have affected the streamflow characteristics of each affected tributary and the mainstem Willamette River. The Willamette Project's large storage facilities are drafted each fall for flood control and refilled each spring for other uses. The Project can also cause unusually large discharge changes over very short periods. These hydrologic effects seasonally modify fish habitat characteristics in the stream reaches downstream from these facilities.

2.4.2 Water Quality

Contaminants

Wastewater runoff and discharge from agricultural and urban land uses also degrades habitat quality in the Willamette basin, particularly in downstream reaches. The mid-Willamette River is currently listed on the Oregon Department of Environmental Quality (DEQ) Clean Water Act 303(d) list of water quality limited water bodies. DEQ listed water quality problems identified in the action area include bacteria (fecal coliform), lead, mercury, dissolved oxygen, and temperature. Wastewater treatment effluents and runoff from agricultural lands contribute to nutrient loads (ODA 2016) which promote harmful bacteria or algal blooms. Municipal and industrial wastewater discharges and runoff from urban or suburban areas can be sources of metals, pesticides, and other toxics, with toxic equivalents increasing with increasing urbanization (i.e., population density, road density) (Waite *et al.* 2008). Research into the discharge of total nitrogen, total phosphorous, and suspended sediment loads by USGS from 1993-2003 showed large inputs from the point sources of municipal wastewater treatment plants and industrial outfalls. Nonpoint sources also contributed to a steady increase down the mainstem, with the largest increase between Salem and Portland (Wise *et al.* 2007).

Temperature

Water development influences water temperatures through storage, diversion, and irrigation return flows. These changes in water temperatures have significant implications for anadromous fish survival. Among the primary water temperature effects of WVS operations is changing the seasonal timing of downstream water temperatures in the tributaries. These changes are due to stratification of water temperatures in the reservoir during the summer months and existing elevations in stratified reservoirs that outlets can draw from. During typical WVS operations, water released in the late-spring and early summer is cooler than what it would be in a riverine system, and then warmer in the fall once warm water near the reservoir surface can be discharged. Cooler water temperatures in late-spring and early summer can delay upstream migration of UWR Chinook salmon. Eggs from spring spawning UWR steelhead also develop more slowly at reduced temperatures. For fall spawning species like UWR Chinook salmon, warmer fall temperatures can delay spawning and accelerate incubation. Warmer fall temperatures can also exceed the thermal tolerance for incubating eggs, reducing viability, and increase thermal stress on adults holding below the dams. For both species, these temperature effects modify emergence timing, and assuming that these fish are well adapted to the environment in which they evolved such changes in emergence timing are maladaptive (Angiletta et al. 2008). The availability of food, water velocities, and predator abundance and feeding efficiency vary seasonally. Therefore, altered emergence timing reduces the potential value of rearing habitat downstream of dams when emerged alevins are present.

Of particular concern in the mainstem Willamette River is water temperatures during the spring emigration of steelhead smolts (April through June). At water temperatures above 15 °C a parasitic myxosporean, *Ceratomyxa shasta*, becomes highly virulent, and recent research has shown that the probability of an outmigrating smolt returning as an adult is reduced when water temperatures exceed 15 °C during outmigration (WRI 2004).

These effects of dams on seasonal temperature conditions in the Willamette Basin are variable among subbasins, and have been partially addressed in some areas. Temperature control operations, in which warm surface water is mixed with cooler lower dam outlet water to achieve closer to normative downstream temperatures, have been implemented at Detroit Dam in the North Santiam River and at Fall Creek Dam in the Middle Fork Willamette River. Such operations are able to partially compensate for the effects of the dams immediately downstream by providing warmer water temperatures in the early summer months and preserving cooler reservoir water to be released during the fall drafting period. However, the ability to provide these temperature benefits is limited by the reservoir elevation and existing infrastructure because once water elevations fall below surface outlets (typically in August or September) such operations are no longer possible. In the South Fork McKenzie River, construction of a Temperature Control Tower at Cougar Dam has allowed greater control, and improved downstream temperature conditions for adults returning to spawn as well as incubating redds in the reach between the dam and the confluence of the South Fork and mainstem McKenzie rivers.

Total Dissolved Gas

Spill at WVS dams can cause downstream waters to become supersaturated with dissolved atmospheric gasses. Supersaturated total dissolved gas (TDG) conditions can cause gas bubble trauma (GBT) in adult and juvenile salmonids resulting in injury or death. Biological monitoring at nearby dams on the Columbia River shows that the incidence of GBT in both migrating smolts and adults remains between 1-2% when TDG concentrations in the upper water column do not exceed 120% of saturation. When those levels are exceeded, there is a corresponding increase in the incidence of signs of GBT symptoms. At times, TDG in WVS dam discharges has exceeded 120% of saturation concentration.

2.4.3 Climate Change

As noted in the Status of the Species above (Section 2.2.1) and further discussed in the Cumulative Effects (Section 2.6), effects of climate change have and will continue to have an increasingly important role in determining the abundance and distribution of ESA-listed salmon species. Climate change leads to increasing stream temperatures, altered timing and quality of stream flows. Figure 2.4-2 shows these and other effects on Chinook salmon life history stages. In the Willamette River, increases in stream temperatures are expected to result from lowered snowpack and snow water equivalent⁷ due to shift in Cascades winter precipitation from snow to rainfall. Lower rainfall in spring and summer months will lead to more years with drought conditions. The distribution of years that were classified by the Corps as abundant shifted to more years with only adequate levels of refill in reservoirs (discussed further in the Effects of the Action, Section 2.5, below). However these adequate years have not always provided sufficient storage to meet current stream targets in the 2008 RPA at Salem. Oregon saw the results of snowpack water scarcity in droughts in 2015 and 2018 (Mote *et al.* 2019). Snowmelt as a source of live flow is expected to decline significantly through mid-century. Natural variability in recent decades has masked these declines since 1985, with recent research showing expected reverses in variability, and much larger declines (Mote *et al.* 2019).

⁷ Snow water equivalent is measured by the NRCS at remote sites and used for streamflow forecasting. It is defined by the NRCS as “the amount of water contained within the snowpack. It can be thought of as the depth of water that would theoretically result if you melted the entire snowpack instantaneously.” (NRCS 2019).

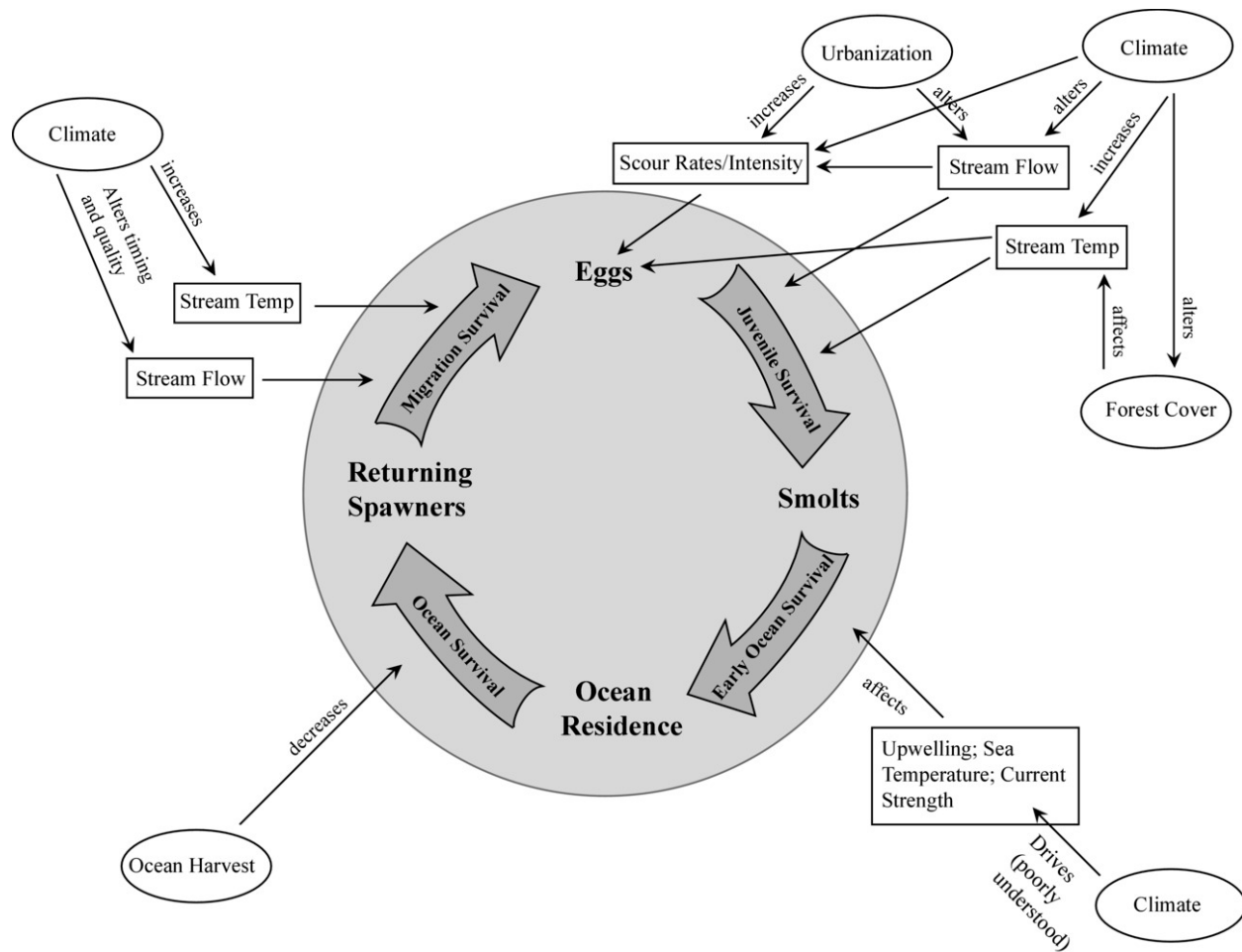


Figure 2.4-2 A conceptual model of potential links between climate, anthropogenic perturbations, habitat condition, and life-stage survival for stream-type Chinook salmon (*Oncorhynchus tshawytscha*) in the interior Pacific Northwest. The salmon life-cycle is included in the circle and broken into life stages sensitive to different environmental factors (ovals, large-scale drivers of survival; rectangles, more proximate and local drivers of survival). Unlabeled arrows indicate that the effect of the driver can be positive or negative, depending on its magnitude or the direction of change. Figure 1 from McClure *et al.* (2013).

Recent decades have seen warm anomalies in the land and ocean region known as the Eastern North Pacific. Estimates of increased air temperatures from recent decades, showing a change in climate compared to the previous century have trended as high as 0.48°C /decade (Figure 2.4-3). Climate models run for local conditions indicate lower June-August runoff, projected to decline 5.3% in the Pacific Northwest over 2011–2050 compared to 1966–2005 under a high emissions pathway (Dalton *et al.* 2017). Further risks arise from the loss of snowpack which acts as a natural reservoir to enhance summertime live flow, from both surface and groundwater supply (Mote *et al.* 2019).

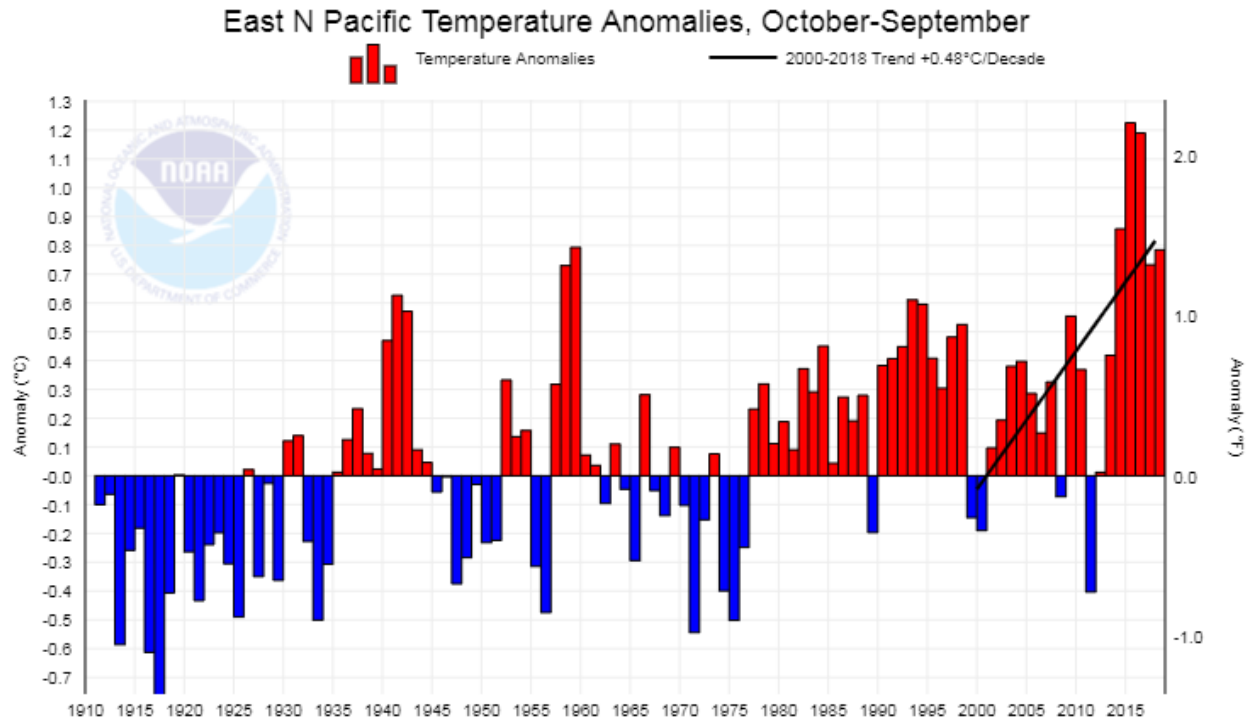
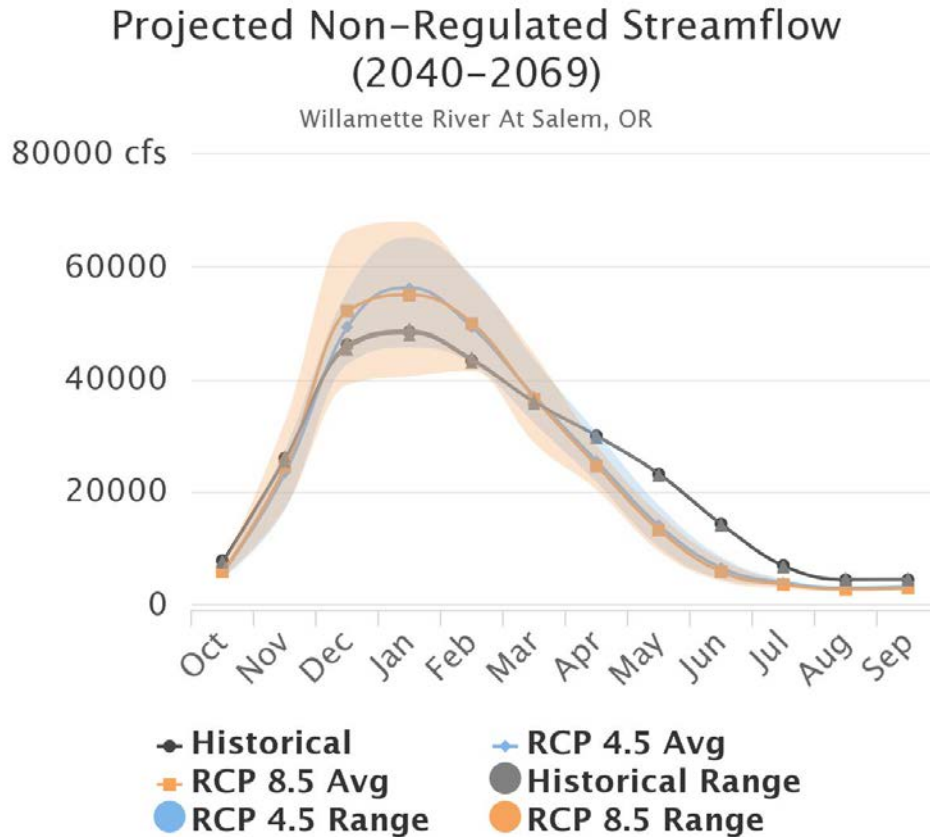


Figure 2.4-3 Land and ocean temperature anomalies in the Eastern North Pacific for 1910-2018, with respect to the 1910-2000 average. The trend line shows increases of 0.48°C/decade from 2000-2018 (NOAA 2019).

Similar to the current increases in temperature trends shown in Figure 2.4-3, climate models for Oregon show larger warming in summer, with western Oregon (outside of coastal areas) increasing in temperature by around 0.4°C per decade (Mote *et al.* 2019), along with decreases in summer precipitation. While some increase in winter precipitation is suggested by model results, only small (<10%) increases are expected west of the Cascades. The net result of the modeled changes in precipitation for the proposed allocation's period of increased diversions, May through September, is a large decrease in the streamflow for the Willamette River at Salem, shown in Figure 2.4-4.



Climate Toolbox, Source: VIC-MACAv2-Livneh CMIP5 Multi-Model Mean Bias-Corrected

Figure 2.4-4 Monthly non-regulated streamflow in the Willamette River at Salem for 2040–2069 under high and low emission scenarios and over the 1971–2000 historical baseline. From Mote et al 2019, Figure 7.

2.4.4 Water Use

According to the Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead (Recovery Plan) (ODFW and NMFS, 2011), and sources cited therein, the Willamette River Basin is home to 70 percent of Oregon’s human population, including Oregon’s three largest cities (Portland, Eugene, and Salem). Moreover, approximately 64 percent of the Basin is in non-Federal ownership, with 34 percent in non-Federal forest use, 22 percent in agricultural production, and eight percent in urban or in other uses. More than 90 percent of the valley floor is privately owned.

Urban consumptive use of water from in-basin sources is small compared to other uses. In the Willamette River Basin agricultural use (475 KAF) is 25 times greater, and regulatory minimum flows in the Willamette River (3,500 to 4,000 KAF at Salem) are 200 times greater (Jaeger *et al.* 2017). This same study found that urban consumptive use is projected to increase by only 16 KAF by 2100, due primarily to population growth, which is predicted to be tempered by recent and near-term price increases related to cost recovery for infrastructure investment related to the cost of water and wastewater services (Jaeger *et al.* 2017). Although this study does not account for individually held municipal water rights and makes some simplifying assumptions about the applicability of existing sources to future users, it is consistent with the trends described in the

BA and draft FR/EA (USACE 2018a and 2018b) showing little existing unmet demand for municipal water, and that municipal water use is small proportional to both agricultural uses and the volumes of water needed to maintain sufficient instream flows. Protection of instream flows under Federal and state law is the largest allocation of water in the Basin under human influence or control. These flows serve multiple purposes, but are determined largely by habitat requirements of native fish (Jaeger *et al.* 2017).

The Recovery Plan identifies an altered hydrograph and reduced water quality as habitat-related threats that are limiting the recovery of both UWR Chinook salmon and UWR steelhead. These threats include changes in the quantity and timing of instream flow and related habitat impacts due in large part to water withdrawals, and wastewater runoff and discharge from agricultural and urban land uses. Among other things, habitat degradation metrics related to these threats must show a positive trend demonstrating that they do not limit attainment of the desired status of the population before NMFS can determine that these species have recovered to the point where they no longer need the protections of the ESA.

2.4.5 Previous Opinions

Since the listing of the species considered in this opinion, NMFS has completed more than 600 Section 7 biological opinions for Federal actions affecting those species and their critical habitats in the action area. Examples of those include the following programmatic biological opinions:

- Farm practices: FSA, Conservation Reserve, NWR-2008-7679, Sep 4, 2015
- Floodplain Insurance: FEMA, NWR-2011-3197, Apr 14, 2016 (Jeopardy/Adverse Mod)
- Federal forest management:
 - BLM Herbicide Use, NWR-2009-5539, Sep 1, 2010
 - Federal Forest Management, NWR-2010-2699/2700/2701, Apr 21, 2011
 - USFS, Willamette Forest Timber Sale Program, WCR-2018-8761, Jun 13, 2018
- Habitat restoration:
 - Bonneville Power Administration, HIP, NWR-2013-9724, Mar 22, 2013
 - Federal Land Managers, ARBO, NWR-2013-9664, Apr 25, 2013
 - USFWS & NOAA Restoration Center, Willamette Floodplain Restoration, Programmatic Restoration Opinion for Joint Ecosystem Conservation by the Services, (PROJECTS) NWR 2012-9318, Jun 19, 2013
 - U.S. Fish and Wildlife Service, Projects, NWR-2013-10221, Dec 3, 2013
 - Corps, Tidal Area Restoration, WCR-2018-8958, May 15, 2018
- In-water/overwater structures: SLOPES, NWR-2011-5585, Apr 5, 2012
- Transportation:
 - Corps, SLOPES, NWR-2008-4070, Aug 13, 2008
 - FHWA, Federal Aid, NWR-2011-5233, Nov 28, 2011
 - Corps, SLOPES, NWR-2013-10411, Mar 14, 2014
- Willamette Valley Project, NWR-2000-2117, Jul 11, 2008 (Jeopardy/Adverse Mod)

Recent examples of individual Section 7 biological opinions issued in the Willamette Basin include:

- FERC, Operation of Carmen-Smith Hydro, WCR-2017-7659, Apr 12, 2018

- Corps, Kinder Morgan Remediation, Willamette River, WCR-2018-10200, Jul 26, 2018
- Corps, PGE Harborton Restoration, Willamette River, WCR-2018-10175, Nov 14, 2018
- Corps, Weddle Gravel Mine Fish Egress Channel Repair, WCR-2017-7755, Feb 8, 2019

Recent Section 7 biological opinions involving temperature or flow management in the Willamette Basin include:

- EPA, Water Quality Standards for Temperature and DO, WCR-2013-76, Nov 3, 2015 (Jeopardy/Adverse Mod)
- Corps, Willamette Water Supply System, WCR-2017-7795, Oct 1, 2018

Three of these consultations that evaluated effects similar or related to the potential effects of the proposed action are described in more detail below.

Water Quality

In 2015, NMFS completed ESA Section 7 consultation on the Environmental Protection Agency's (EPA's) proposed approval of certain Oregon water quality standards, including temperature and intergravel dissolved oxygen to implement Clean Water Act protection of cold water refuges (NMFS 2015). The opinion concluded that the proposed standards would jeopardize the continued existence of UWR Chinook salmon and steelhead as well as several other species of Columbia basin salmonids, and provided a Reasonable and Prudent Alternative (RPA). Under the RPA, DEQ and EPA will develop cold water refuge plans for the Willamette and Columbia Rivers. The proposed migration corridor criterion has two parts, numeric maximum of 20°C, and a narrative to ensure thermal refuge is available to protect salmon and steelhead migration reaches. The purpose of the plans is to adequately interpret the narrative criterion to allow for implementation of the criterion through DEQ's Clean Water Act authorities. Current investigations in the action area conducted by Oregon Department of Environmental Quality, under the supervision of the EPA, will assist in finding current cold water refuges, and determining if there are sufficient areas in migration corridors are protected during warmer periods (NMFS 2015). The area for the migration corridors is defined as the lower 50 miles of the Willamette, and thus overlaps with the reaches below Salem affected by the changes in meeting targets and greatest proportion of the proposed new diversions.

Willamette Water Supply System

Consultation on the issuance of a permit for the Willamette Water Supply System included analysis of proposed modifications to an existing Willamette River intake in the Newberg pool and development of a new water treatment plant, which would expand the capacity of the existing intake. Analysis of construction impacts as well as the increased diversion of water found that the action was likely to have minimal or temporary adverse impacts to ESA-listed salmonids but was not likely to jeopardize any species within the action area or adversely modify their critical habitats. This conclusion for long-term effects of the withdrawal was largely based on the magnitude of effects as well as their location. While the withdrawal would increase the flow diverted at that location by as much as 100 cfs, temperature modeling showed that the maximum temperature increase at the Newberg pool was limited to 0.11°C, below the 0.3-degree C impact threshold in the Willamette River established by the Oregon Department of

Environmental Quality to protect aquatic ecosystems, particularly salmonids (OAR 340-041-0028). The location of the withdrawal was also not high quality rearing habitat or an area where adult salmonids would be expected to hold, and flows were additionally protected by “fish persistence” water rights conditions that reduce or prohibit access to water when streamflow at Salem is below fish flow targets.

Willamette Valley Project

The ongoing effects of the existence and operation of the WVS on UWR Chinook salmon and steelhead were the subject of formal ESA Section 7 consultation from 2000 to 2008, as described in Section 1 (Introduction). NMFS assessed the ongoing operation and maintenance of the Willamette Valley Project and found it was likely to jeopardize the continued existence of UWR Chinook salmon and steelhead, and provided an RPA with several measures to allow the Action Agencies to operate the project in a way that would avoid jeopardizing UWR species. The RPA included measures to address fish passage, flow management, water quality, water contracts, habitat, and hatchery actions. Measures are at various stages of completion, and the status of these actions directly impacts the environmental baseline in the action area.

Fish Passage

Blocked access to historical habitat is identified as the most critical limiting factor for UWR Chinook salmon and steelhead (ODFW and NMFS 2011). The RPA contained several measures for improving fish passage, both as upstream passage for adults and downstream passage for juveniles. Adult fish facilities for upstream transport have been improved at four locations (below Detroit, Foster, Cougar, and Fall Creek Dams), although in the Middle Fork Willamette, the Dexter Fish Facility has yet to be upgraded and although it remains part of the RPA NMFS is not assuming benefits from its completion by a particular date for the purposes of this Opinion. Adult outplanting sites have also been improved above the dams in the four major east-side Willamette tributaries (i.e., North and South Santiam, McKenzie, and Middle Fork Willamette Rivers). Adult Chinook salmon and steelhead outplanting above dams continues throughout the Willamette Basin, although adults have not yet been outplanted above Green Peter Dam in preparation for future reintroduction at that location, and this Opinion does not assume benefits associated with outplanting by a particular date for the purposes of this Opinion. These actions have reduced pre-spawning mortality (PSM) below dams and improved spawning productivity above dams in the North Santiam and South Fork McKenzie River, although currently juveniles produced above the dams are not able to migrate downstream safely at any WVS dams.

The RPA called for safe, timely, and effective downstream passage to be implemented at Cougar, Detroit, and Lookout Point Dams by 2023;

- Cougar: downstream passage improvements were to be completed by 2014, although they have not yet been constructed. Current planning and construction schedules estimate construction will be complete by 2021.
- Detroit: downstream passage improvements were to be complete by 2023, although they have not yet been constructed. Current planning and construction schedules estimate construction will be complete by 2027.

- Lookout Point: downstream fish passage improvements were to be complete by 2021, although in 2014 an agreement was made between NMFS and the Action Agencies to prioritize the North Santiam and complete improvements at Lookout Point after the other major tributaries. This remains under discussion by the agencies. This Opinion does not assume any benefits associated with completion of this measure by a particular date.
- Foster: RPA measures related to spill operations called for modifications to improve fish passage, which resulted in an improved fish weir to be complete by 2018. While the new weir is in now place, it is still not passing juveniles and steelhead kelts⁸ safely, so further improvements are planned to improve passage survival.

The RPA also called for interim fish passage measures to be implemented wherever feasible using existing infrastructure, although these are currently only regularly performed at Fall Creek. Research to inform upstream fish passage, downstream fish passage, and interim passage management decisions is ongoing.

Habitat

Assessments of habitat quality and potential for habitat enhancement have been completed, as well as several restoration projects which have been funded by the Bonneville Power Authority, Meyer Memorial Trust, OWEB and NOAA Restoration Center, totaling over approximately 1,260 acres of the target 2,600 acres habitat target for 2022. This represents floodplain forest, reconnected channels, and control of aquatic invasive plants projects along the mainstem Willamette River (WAHWG 2019). Opportunities to improve habitat on Corps-owned property were not identified, and while priority sites have been identified for modification of Corps-owned revetments, none have yet been pursued.

Hatcheries

A series of measures were prescribed related to managing the hatchery program in the basin to ensure that the WVS hatchery programs were not reducing the viability of UWR Chinook salmon or steelhead. These focused on the development of Hatchery and Genetic Management Plans to provide detailed guidance on hatchery policies and procedures, which have since been completed. The RPA also included hatchery facility improvements, fish marking, changes in the sizes and locations of certain program releases, and incorporation of UWR Chinook salmon conservation hatchery practices, all with the aim of minimizing the influence of hatchery stocks on natural-origin fish. All of these measures with the exception of two structural actions have been completed, and this portion of the RPA superseded by the current biological opinion on the hatchery program (NMFS 2019).

Flow Management

The central element of the flow management RPA measures are instream flow targets for the mainstem Willamette and tributaries below WVS dams. These targets have been implemented since prior to completion of the 2008 BiOp, although they have been met less frequently than was originally predicted by ResSim modeling conducted during the 2008 consultation (see

⁸ Kelts are adult steelhead that return to the ocean after spawning.

Baseline Water Quality, below). The RPA also acknowledged a lack of available data on optimum flow targets in the basin, and called for further study on mainstem and tributary flow targets, as well as revisions of those targets if new information demonstrated it was appropriate. These studies are ongoing, with tributary instream flow studies scheduled to be completed in 2020.

To monitor flow target performance, the RPA also required Action Agencies to install gage stations near the confluences of the major tributaries impacted by project operations. Those have been completed, and ramping rates to minimize stranding risk have been implemented, although the accompanying research to verify the adequacy of ramp rate restrictions has not been done. RPA requirements for pulse or “environmental” flows have been implemented in part, and spill operations for passage were implemented at Foster until the new weir was installed.

The RPA also required Action Agencies to have determined the path forward with appropriate agencies to protect stored water released for fish as instream flow water rights by 2009. While that has not yet been accomplished, one component of this proposed action is to help facilitate that process.

Water Contract Program

Under the existing RPA, BOR had issued irrigation water supply contracts for a total of approximately 82 kAF of conservation storage as of spring 2019 (USACE 2019c). The RPA requires that all contracts be subject to the availability of water, and no further contracts could be issued in the North or South Santiam Rivers that would exceed existing totals. Intakes for all contracted diversions were also required to be screened to NMFS criteria (NMFS 2011a) and new contract holders were required to have instantaneous monitoring and easily adjustable headgates at their diversions, all of which has been implemented.

The annual availability of water for irrigation contracts is also subject to curtailment based on the availability of water under the RPA, and in deficit years deliveries are required to be reduced or cutoff as needed to provide flows for fish. However, the system has experienced deficit years such as 2015 since the implementation of the 2008 BiOp and users were not cut off; instead the Corps agreed to release some additional flows to meet contract obligations, while not meeting mainstem and tributary targets. While the mechanism exists to cut users off to protect minimum flow targets and contract holders have been warned that could occur, this has not yet happened during management of the system.

Water Quality

The RPA required structural and operational measures to address water quality below the dams. The largest of these was a temperature control structure at Detroit Dam which was to be complete by 2018. The tower is currently being designed, and construction is now scheduled to be completed by 2023. Interim temperature control using operational measures at Detroit has been fairly successful at improving downstream temperature conditions in the first half of the conservation season, although these improvements are lost once the reservoir elevation falls below the spillway crest, typically by early August (USACE 2019b). Interim operations have

also somewhat improved temperatures below Fall Creek dam. Operations have also been implemented at Big Cliff dam in order to dissipate TDG, although these changes have not been observed to greatly improve conditions downstream (USACE 2019b).

2.5 Effects of the Action

Under the ESA, “effects of the action” means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.

Some of the indirect effects are related to the actions that will follow from the reallocation of the storage in the reservoirs across the Willamette Project, and require actions by other agencies but are otherwise reasonably certain to occur.

Key Assumptions of Proposed Action Implementation

The proposed action assumes a Water Resources Development Act (WRDA) bill would be passed by Congress to uphold the specific recommendations in the Chief’s Report which is consistent with the ARP. In this instance, the Corps is proposing a reallocation of conservation storage to include 159,750 acre-feet (af) to meet future peak demands for M&I, and 327,650 af for future peak needs of AI as discussed in the Proposed Action section (Section 1.3). The remaining storage in the basin is calculated by subtracting these future estimated demands from a potential maximum total of 1,590,000 af (or 1.59 million acre-feet, MAF) to leave 1,102,600 af (approximately 1.1 MAF). This remaining storage is designated as F&W use, and is reduced from the current total used to meet the 2008 BiOp target in many years. The Supplemental Biological Assessment (USACE 2007) for the earlier consultation in 2008 had defined four levels of storage availability: “deficit,” “insufficient,” “adequate,” and “abundant” and proposed a change in management approaches for years that were below adequate (Table 2.5-1). Based on May conservation storage volumes, mainstem minimum flow objectives during spring, summer, and fall were proposed to be met or exceeded whenever possible (USACE 2007, Appendix D). However, for drier years, below a cutoff of 1.20 million acre-feet (MAF), they proposed lower flow targets at Salem, below the biological and Congressional minimum flow objectives. The deficit year-type cutoff was 0.9 MAF, with deficit weekly averages proposed for Salem varying by season (USACE 2007, Table D-4). For insufficient years, between deficit and abundant, the Corps proposed to use a sliding scale for these targets. Based on data from the years between 1936 and 1999, they calculated the frequency of each of the four-year types.

Table 2.5-1 Year types used for altering flow targets in the mainstem Willamette River after the Corps Supplemental Biological Assessment (USACE 2007).

Volume in Storage by 10-20 May (MAF)	Designation	Occurrences (years)	Percent of Years
< 0.9	Deficit	10	16
0.9 – 1.19	Insufficient	6	9
1.20 – 1.48	Adequate	11	17
> 1.48	Abundant	37	58
1.59	Maximum *	---	---

*Maximum volume is 1.59 million acre-feet (MAF), if reservoirs fill completely.

Source: Supplemental BA Table D-3 (USACE 2007). Evaluation of Spring Runoff and Conservation Operation (using period of record 1936-1999 for occurrence and percent of years for each flow type).

In contrast, the current proposal to reallocate water includes a management approach called proportional reduction, so that in any year where the full conservation storage volume of 1.59 MAF is not met, the new users would be allocated a lower volume based on the share allocated to them and the fraction of the total 1.59 MAF possible volume. The Corps used the year types described above to model the proportional reductions, using HEC-ResSim simulation software. They provided tables with calculated levels of diversions by reach for the four-year types (USACE 2018b, Appendix G). The median volumes used for increased diversions are shown in Table 2.5-2.

Table 2.5-2 Under the re-allocation, the Corps proposed proportional reduction of storage allocations in any years without 100% refill, resulting in reduced storage flows available for diversions for new users and for meeting 2008 RPA minimum flow objectives. Percent of years calculated from 1936-2008, although recent distribution shows fewer abundant years.

Median Storage Volume mid-May (MAF)	Year Type Designation	% refill/available supply	Occurrences (years)	Percent of Years
0.76	Deficit	48%	11	14%
1.10	Insufficient	69%	11	14%
1.37	Adequate	86%	14	17.5%
1.57	Abundant	~100%	44	55%

Reductions to allocations for the current minimum targets are proposed for all years below abundant storage volume under proportional reduction, which will lower flow and affect fish and habitat as discussed below. The median represents a mid-point reduction, for example 86% full in adequate years, although 75% full would be a low adequate year near the 1.2MAF cutoff.

Although the proposed action would lead to reduced storage available for all water uses, when refill percentage is lower than abundant, new demands would be allowed to divert for future peak needs, and the likelihood of meeting current 2008 RPA targets would be reduced accordingly. The ‘proportional reduction’ name describes shared shortfalls in years where the reservoirs do not fill to the maximum possible levels. Hence it applies to more years than current inadequate years, and would also reduce instream flows more than current insufficient or deficit targets.

Diversions for new peak demands, even when proportionally reduced, will lower instream flows currently protected for fish survival and habitat. Future opportunities to provide legal protection for state designated Minimum Perennial Stream Flows exist, yet it is not reasonably certain that these flows will be provided before new consumptive uses are contracted and delivered. Numerous steps and potential challenges were detailed above in the Analytical Approach (Section 2.1).

The maps in the Analytical Approach Section 2.1 showed the distribution of predicted future withdrawals by reach. Notably, most of the proposed diversions will affect the mainstem flows, primarily below Salem, while mainstem Willamette River minimum flow objectives are measured at Salem (USGS gage 14191000, as noted in NMFS 2008 Table 9.2-1). Given the substantial number of new diversions below Salem that would result from the proposed action, these minimum objectives would no longer provide adequate flows in most years for fish and habitat in the 60 miles between Salem and the Willamette Falls. As noted above in Section 2.4.4, this reach of the mainstem overlaps with the designated migration corridor where cold water refuges have been identified as important for survival and recovery of UWR Chinook salmon and steelhead in consultation with the EPA (NMFS 2015).

Harm to UWR Chinook salmon spawners will result from increased diversions in the mainstem due to the proposed action's allocation and changes to management. This harm is described in detail below.

UWR steelhead migrate to the spawning grounds in the fall, winter, and spring. This migration coincides with periods of adequate streamflow and low stream temperature. Due to this earlier migration timing for UWR steelhead adults (as compared to UWR Chinook salmon), most adult fish will have moved upstream past the Salem to Willamette Falls reach prior to yearly withdrawal of water from the many potential new diversions. However, the proposed action will cause effects on outmigrating juvenile steelhead in the mainstem Willamette River, and to juvenile rearing areas in the North and South Santiam Rivers as further described below.

2.5.1 Effects of the Proposed Action on Listed Species

UWR Chinook: Mainstem Willamette River Diversions

In this section, we review the impacts of increased water diversions that would result from the proposed allocations. We expect water to be diverted from May to September, the conservation season for the Corps reservoirs when they have stored water to release for new water rights contracted for peak municipal and industrial (M&I) and agricultural irrigation (AI) users. Increased diversions resulting from the proposed action will lead to warmer water temperatures in the mainstem. This increase in water temperature will harm UWR Chinook adult spawners migrating upstream, by increasing mortality prior to spawning.

In the BA, the Corps provided tables that identify diversions by river reach and month. For the purpose of their analysis, the Corps divided the Willamette River into 15 reaches. The tables show combined total M&I and AI (diversions) in cubic feet per second (cfs) (Tables 9.15-9.18 in Appendix G, USACE 2018b). In these tables, the reach labeled 1 includes all mainstem

Willamette River diversions below the Santiam River confluence (Figures 2.1-1 and 2.1-2 in Section 2.1, Analytical Approach).

Reach 1 has particular importance to adult UWR Chinook salmon (excluding the Clackamas population) because all populations migrating above Willamette Falls to upstream tributaries must travel through this reach. The Corps split diversion locations for Reach 1 into three sub-reaches, 1a–c: Reach 1c is from the Santiam River confluence to Salem; Reach 1b is from Salem to Willamette Falls; and Reach 1a is from Willamette Falls to the confluence with the Columbia. Appendix G tables did not include diversions in Reach 1a, and while the effects of diversions below Willamette Falls are in addition to those from diversions in reaches above the Falls, we did not quantify them in our analysis.⁹ Instead, we focused on combined diversions from Reaches 1b and 1c to assess the impact on populations migrating through Reach 1. The total proposed diversions ranged from peaks of 540 cfs in deficit years to 1100 cfs in abundant years during peak summer months (Tables 9.15-9.18 in Appendix G, USACE 2018b). Using these diversions, we were able to compare current minimum flows at Salem, less projected changes resulting from the proposed action, to review possible effects on water temperatures.

The Corps also calculated possible offsets of the diversions that could return to the river from wastewater treatment plants (WWTPs) and agricultural irrigation via groundwater recharge. Theoretically, return flows lower the instream flow loss from M&I and AI diversions, at assumed rates of 55% for M&I and 20% for AI diversions (USACE 2018b). For M&I, the BA stated that return flows would be back in the river on the same day, and for AI, within a month, for sprinkler irrigation (USACE 2018b, Appendix G). While the Corps assumed these percentages for return flows from WWTPs and agricultural irrigation via groundwater, such flows would be uncertain to return to the same reach, would have increased contaminants and warmer temperatures, and would be unreliable due to higher evaporation and increased irrigation efficiency. For M&I, peak increases during summer would be applied to landscaping, and hence little would return downstream from WWTPs (Portland Bureau of Environmental Services 2019). WWTPs are often located far from the point of diversion, and so cannot replace diverted instream flows in the same reach. Due to the uncertainties associated with return flows, we did not consider the potential contribution of return in our analysis of reduced instream flow resulting from the proposed action.

The USGS has produced a flow-temperature regression model to examine effects of changes in flow in the Willamette River, and has presented methods and early results to technical teams (Rounds 2017), and at the Willamette Fisheries Science Review (Stratton *et al.* 2019). We obtained the model for peer review and tested scenarios with the new diversions. Although still in peer review, we consider this model the best available science because it has high predictive accuracy when compared to observed data. The model is the most recent version of a model that USGS has been refining for several years and is an updated version of the temperature-regression model the Corps used to develop their BA.

The model predicts water temperature from air temperature and flow. Using the diversions shown in Appendix G (USACE 2018b), we calculated the change in water temperature below

⁹ The Corps does not have Res-Sim results for flows below Willamette Falls, so did not quantify the diversions from new demands in Reach 1a.

Salem from the increased diversions that would result from the proposed action, assuming contracting to meet 2070 demand. As noted above in the Analytical Approach, increases in both M&I and AI contracts for storage beyond existing caps are reasonably certain to occur over the next 50 years, so we evaluated the effects of contracting the full allocations of water for M&I and AI, and did not limit this analysis to the temporary 2030 caps presented in the BA.

Using the USGS regression model, we show relationships suggesting that diversions of the reported magnitude, 600 to 1100 cfs, would result in notable temperature increases. In the scenarios when we used dry year (2015) conditions and proposed diversions, model results showed daily mean water temperature increases from 0.2°C to 0.8°C, and during an average (i.e., mid-range adequate) year (2013), daily mean water temperature increases from 0.1°C to 0.8°C. Increasing water temperature will affect adult Chinook salmon migrating in June through August, when they are in the reach between Willamette Falls and the Santiam River for up to weeks, varying in length by their timing passing Willamette Falls.

The results presented above do not match the analysis included in the BA, in part because the Corps analysis was limited to diversions for contracting to meet 2030 demand. However, during consultation, the Corps provided updated results from USGS modelling which corroborated the results of our analyses showing temperature increases from 2070 demand levels of increased diversions. The updated USGS model outputs sent by the Corps showed 7-Day Average of the Daily Mean (7dADM) temperatures increased from 0.1°C to 1.4°C when diversions were between 200 and 1100 cfs (USACE 2019d).

The increase in stream temperature from increased diversion will have an adverse impact on migrating adult UWR Chinook salmon. Schreck et al. (1994, cited in McCullough 1999) detected negative consequences of migrating in water temperatures in the range 21-25° C, in the Willamette River above Willamette Falls. Several studies of effects of temperature on UWR Chinook populations were conducted recently (Keefer et al. 2015, Jepson et al. 2013, Bowerman et al 2018). These provide specific information to analyze the impacts of water temperature on UWR Chinook. Keefer et al (2015) summarize as:

“Willamette River water temperatures during the adult spring Chinook salmon migration routinely exceed thresholds considered stressful for the species. In most years, temperatures of 20–24 °C occur for days to weeks in the lower 200 km of the river, coincident with adult passage (May–August). Temperatures in this range have been linked to a variety of stress responses and sub-lethal effects in adult Pacific salmon (reviews by Richter and Kolmes 2005, McCullough et al. 2009, Hinch et al., 2012). Behavioral responses include migration delay or cessation (Yates et al 2008 Caudill et al. 2013) and the use of cool-water refuges (Berman and Quinn 1991, Goniea et al. 2006, Strange, 2012). Physiological responses include accelerated maturation (Berman 1990, McCullough et al. 2001), depletion of energetic reserves needed to complete migration and reproduction (Brett 1995, Lee et al., 2003, Rand et al. 2006), and increased susceptibility to several pathogens (Kocan et al. 2004, Wagner et al. 2005, Kent et al. 2013). Individually or in combination, these effects likely explain the episodically high prespawn mortality in Willamette basin Chinook salmon (Keefer et al. 2010, Roumasset 2012).”

During a 2011-2012 study of UWR Chinook salmon migrating upstream in the Willamette River, internal fish temperatures recovered from temperature loggers were positively associated with USGS gage water temperatures in most study reaches (Jepson et al. 2013). Preliminary results show a relationship between UWR Chinook salmon temperature exposure and river temperature measured at nearby USGS gage sites. In other words, the USGS's gage temperature data accurately reflect the conditions UWR Chinook experience.

Further analysis allowed Jepson et al. (2013) to use 2012 logger data and predicted temperatures to estimate degree-day accumulations¹⁰ in the study's tagged salmon, which generally had high agreement with actual degree-day accumulation rates from the loggers. Adult salmon were in the mainstem for two to six weeks before reaching tributaries, longer for populations migrating to farther upstream tributaries (Jepson et al 2013). These studies show that adult spawners in the mainstem are subject to harmful thermal exposure even before the increases in water temperature due to diversions that would result from the proposed allocations.

Other researchers have found correlations between temperature and pre-spawn mortality (PSM), with higher risk of PSM for increased temperature or more days of exposure, adding to accumulated degree-days. The strong positive association between PSM and accumulated degree-days was noted in a study of Willamette Chinook salmon by Schreck et al (2013, cited in Jepson et al 2013), characterizing accumulated degree-days as "a simple, biologically relevant metric since it is associated with thermal exposure, pathogen dynamics, and energetic status." Naughton et al. (2014) further noted that "managing water temperatures below the [Willamette] dams during spring Chinook migration to reduce stress, disease and reduce prespawning mortality should be considered."

The Willamette River, particularly below Salem, is often above the 20°C temperature criterion for migration corridors (NMFS 2015) during migration months (Figure 2.5-1). Increased prespawning mortalities with higher water temperatures were seen in female Chinook salmon spawners across reaches in all Willamette tributaries, reviewed using a metric of annual maximum peak daily temperature (Bowerman et al. 2018). This study found higher PSM in streams with higher temperatures, and when holding a similar predictive variable constant (percent hatchery-origin spawners), they continued to find higher water temperature to be predictive of increased PSM. As noted by Keefer et al (2015), "Thermal exposure in this population complex proximately influences adult salmon physiology, maturation, and disease processes and ultimately affects prespawn mortality and fitness." The proposed additional diversions are likely to increase temperatures, which increase accumulated degree-days for migrating spawners, increasing the risk of PSM.

As described above in the Environmental Baseline, Section 2.4, increased air temperatures from recent decades compared to the previous century show trends of 0.48°C /decade (NOAA 2019) that if continued, as predicted by climate models (Mote et al. 2019), would also increase water temperatures between now and 2070. Higher water temperatures, due to climate change in addition to diversions, would apply an even greater risk of higher PSM, over the proposed allocation time frame. Climate models run for local conditions also predict 5.3% lower June-

¹⁰ Degree day is defined as a measure of cumulative temperature exposure, and calculated by summing the average daily temperature exposure above 0 °C. The rate is in degree days per day

August runoff over 2011–2050 (Dalton et al. 2017). Lower snowpack adds to the risk of lower live flow during lowest flow periods, with reduced snowpack already exacerbating regional droughts in 2015 and 2018 (Mote et al. 2019).

Already high water temperatures, if further increased by reduced flows, will harm migrating UWR Chinook salmon. The water temperature of the mainstem Willamette River has been measured since 2001 at Keizer, Oregon, a few miles downstream from Salem, and the results in Figure 2.5-1 are for two year types, drier than average (2015) and wetter (2013). In both years, temperatures regularly exceed 18°C during June, and are above the 20°C criterion for spawner migration throughout July and August (NMFS 2015). These are the same months that peak diversions would result from the WBR proposed allocations. Metabolic costs of migration increase at temperatures above 18°C, which are physiologically stressful to salmon (Jepson *et al.* 2013). In the Jepson et al (2013) study, UWR Chinook adults which experienced temperatures above 18°C also had exposure times extended one to three weeks.

The combination of increased degree-days, warmer water from the proposed action allocations leading to lower flows, and climate change effects on flows and temperatures, together would lead to increased numbers of female spawners found as prespawning mortalities. All UWR Chinook salmon populations considered in this opinion are affected by temperatures in the reach below Salem. In contrast to the populations that move above the Willamette Falls, the UWR Chinook salmon population in the Clackamas River has not shown the same decline in recent returns (2015-2018), and this river has lower temperatures and lower PSM. The PSM from spawning surveys in recent years are shown in Table 2.5-3.

Additionally, considerably more adults are counted at Willamette Falls than are ever found in spawner surveys, or at upstream counting stations at dams or adult fish facilities. These fish disappear somewhere between Willamette Falls and areas where they spawn. These lost spawners from all UWR Chinook salmon populations above Willamette Falls represent a serious impediment to recovery of the species.

Decreasing flow leading to higher temperatures may add to the numbers of UWR Chinook salmon that die before reaching spawning areas. Overall effects of the decreased flows from diversions resulting from allocations in the proposed action will be higher water temperatures, compounded by higher air temperatures and lower live flows under climate change. These will lead to increased prespawning mortalities, and reduce the abundance and productivity of the North and South Santiam, Middle Fork, and McKenzie populations of UWR Chinook, impeding recovery targets over the coming decades.

Table 2.5-3 Summary data from Chinook salmon female prespawning mortality (PSM) in Willamette River basin tributary reaches, with years (N), mean, and range (in parentheses) of PSM values. Table extracted from Bowerman *et al.* (2018).

Survey reach	N (years)	PSM (%)
Clackamas	8	15 (4–33)
Lower North Santiam	6	90 (74–99)
Upper North Santiam	14	40 (16–75)
South Santiam	14	22 (8–72)
Lower McKenzie	14	31 (9–60)
Upper McKenzie	14	6 (1–17)
Middle Fork Willamette	14	80 (17–100)

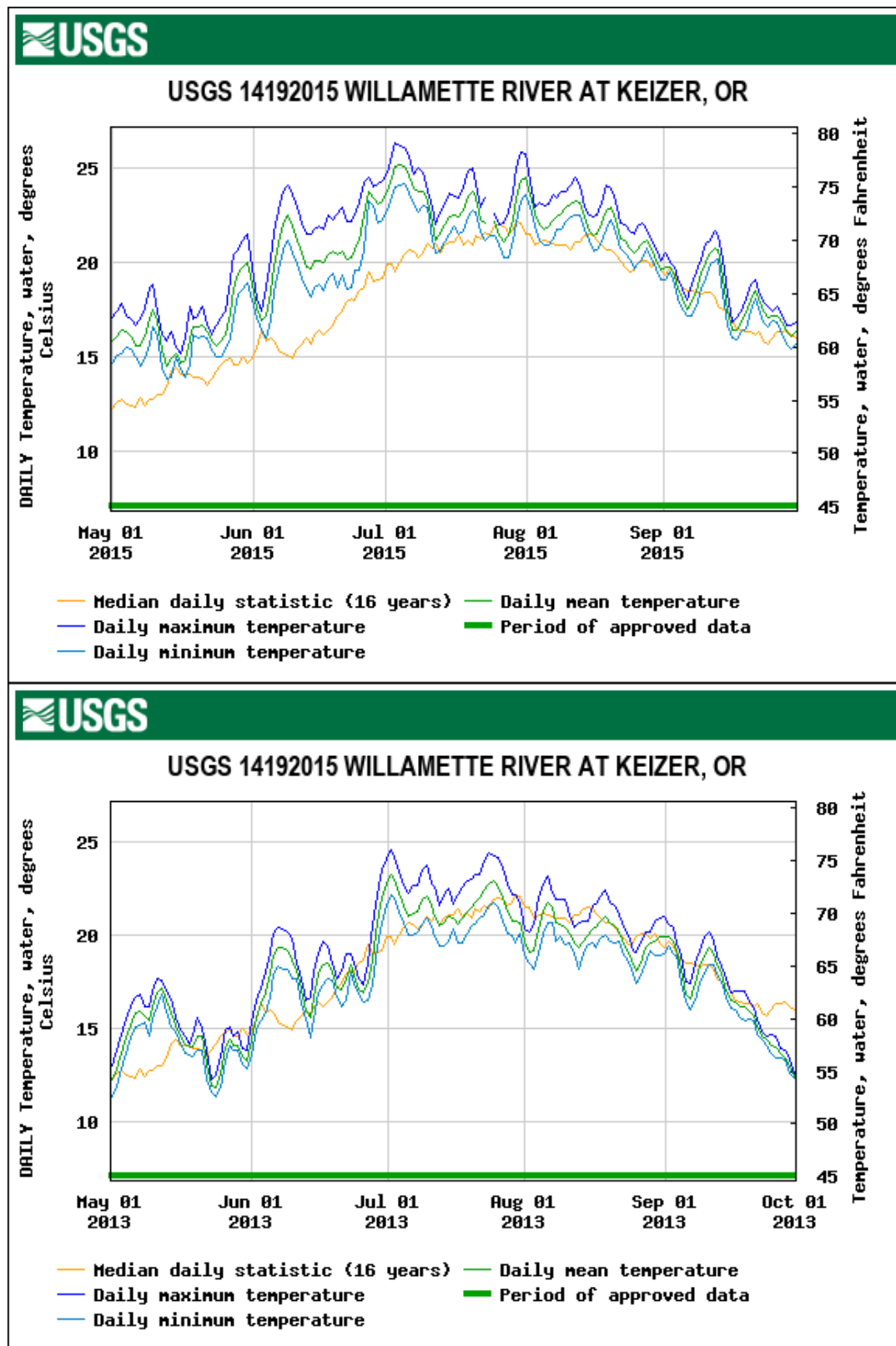


Figure 2.5-1 Temperatures in summer months at Keizer near Salem, for 2015 and 2013. Dry warm conditions in 2015 contrast with cooler wetter conditions in 2013.

UWR Winter Steelhead: Mainstem Willamette River Diversions

Adults

Adult steelhead migrate upstream past Willamette Falls usually between December and May, with median counts during late February and early March (Jepson et al. 2013). They generally begin spawning in tributaries by late April, and so are less affected by changes in mainstem flow due to the proposed allocation increasing diversions in May through September. Adult winter steelhead migrating to the tributaries are moving at rates of up to 30 miles/day (Jepson et al. 2013). Because May flows in the mainstem are higher than June through September, and the diversions during May resulting from the proposed allocations are lower (Appendix G, USACE 2018b), the proposed action would have limited effects on adult steelhead in the mainstem. As noted by Zabel et al. (2015) describing steelhead life cycle modeling for VSP analysis, “Steelhead models did not include PSM and other temperature related effects because the timing of winter-run steelhead adult return and subsequent egg incubation do not occur during periods of temperature extremes.”

Juveniles

There are two possible pathways for diversions to affect juvenile UWR steelhead; when changes in flows affect outmigration in the mainstem Willamette, and when changes in the tributary flows affect spawning, incubation and rearing. The latter will be discussed below in the tributary section.

Targets to provide downstream migration flows during April through June were set prior to the 2008 BiOp, above the Congressionally-authorized minimum flows (USACE 2007), so as to mimic some of the pre-dam hydrology. Corps operations are geared toward meeting these goals in the spring, and could be compromised by efforts to hold back flow if filling reservoirs to supply new diversions was prioritized, or if proposed reductions of F&W stored water under proportional reduction management resulted in missing spring targets.

During dry and warm years, juveniles that are outmigrating as late as May and June would be subject to warmer, lower flows. Juvenile steelhead crossing Willamette Falls are mostly found as two-year-olds, leaving during spring peak flows. Zabel et al. (2015) described steelhead outmigration as follows: “Entering the ocean as a second-year smolt is the most common juvenile life history strategy in the Lower Columbia and Upper Willamette basins (Myers et al. 2006). Recent examination of emigrating juveniles at Willamette Falls indicates only 2-year-old smolts passing the Falls” (citing Monzyk personal communication Nov 1, 2013).

Juvenile steelhead mainstem outmigration would be most affected by the proposed allocation increasing diversions, affecting migration timing and water temperatures, which in turn may reduce survival, and the potential to return as adults. For example, outmigrating juvenile steelhead experienced extreme low flows in the 2015 drought year. Higher water temperatures in May (Figure 2.5-1) would have stressed outmigrating juveniles, exacerbated by lower flows, well below the 2008 RPA minimum deficit target of 15,000 cfs (Figure 2.5-2). Returning adult counts from 2017 and 2018 reflect the reduced survival of these outmigrants, and are the lowest counts on record at 16-33% of the 10-year average (ODFW 2017-2018 annual counts). Flows

were below 10,000 cfs in May, dropping to 7,000 cfs by mid-June (Figure 2.5-2), instead of deficit targets of 15,000 cfs in May to 11,000 cfs in the first half of June. This large deviation from targets, along with warmer air temperatures, increased mainstem water temperatures (Figure 2.5-2). This type of departure from current deficit targets with potential harm to outmigrants would likely be repeated if new demands cause the Corps to reduce allocation for fish survival, under the proportional reduction management strategy.

The probability of an outmigrating smolt returning as an adult is reduced when water temperatures exceed 15 °C during outmigration. This is partially due to the effects of parasitic myxosporean, *Ceratomyxa shasta*, which research showed becomes highly virulent above that threshold (WRI 2004). This temperature was exceeded in June in the Willamette River at Keizer, in all but one year following the 2008 RPA (note median line in Figure 2.5-2). Similar effects on juveniles during outmigration will be most likely seen in warmer years, when the flows are crucial and reduced by to the proposed allocation leading to increased diversions.

In overall conclusions for VSP modeling of UWR Chinook and UWR steelhead populations Zabel et al (2015), focused on evaluating downstream passage options. However, they also addressed future efforts to change hatchery influence, pre-spawning mortality, egg viability, and capacity estimates. For effects from diversions changing temperatures, changes in egg viability is notable for the “potentially equally important [] effect of non-lethal temperature levels or levels of contaminants on the viability of gametes” (p. 2.21). Discussing capacity estimates for other than spawner–egg life stages (primarily used to populate the life cycle model density dependence), Zabel et al (2015) noted: “rearing capacities may be limiting in some reaches, but were not available for inclusion in the SLAM model...Capacity limits may be different for different age classes, in part due to the degree to which either resource (food) limitations, social interactions, or refuge habitat (refuge from flow events and/or thermal extremes) control juvenile density.” Thermal extremes would be more likely to affect juvenile density when the increased diversions create areas of warmer temperatures.

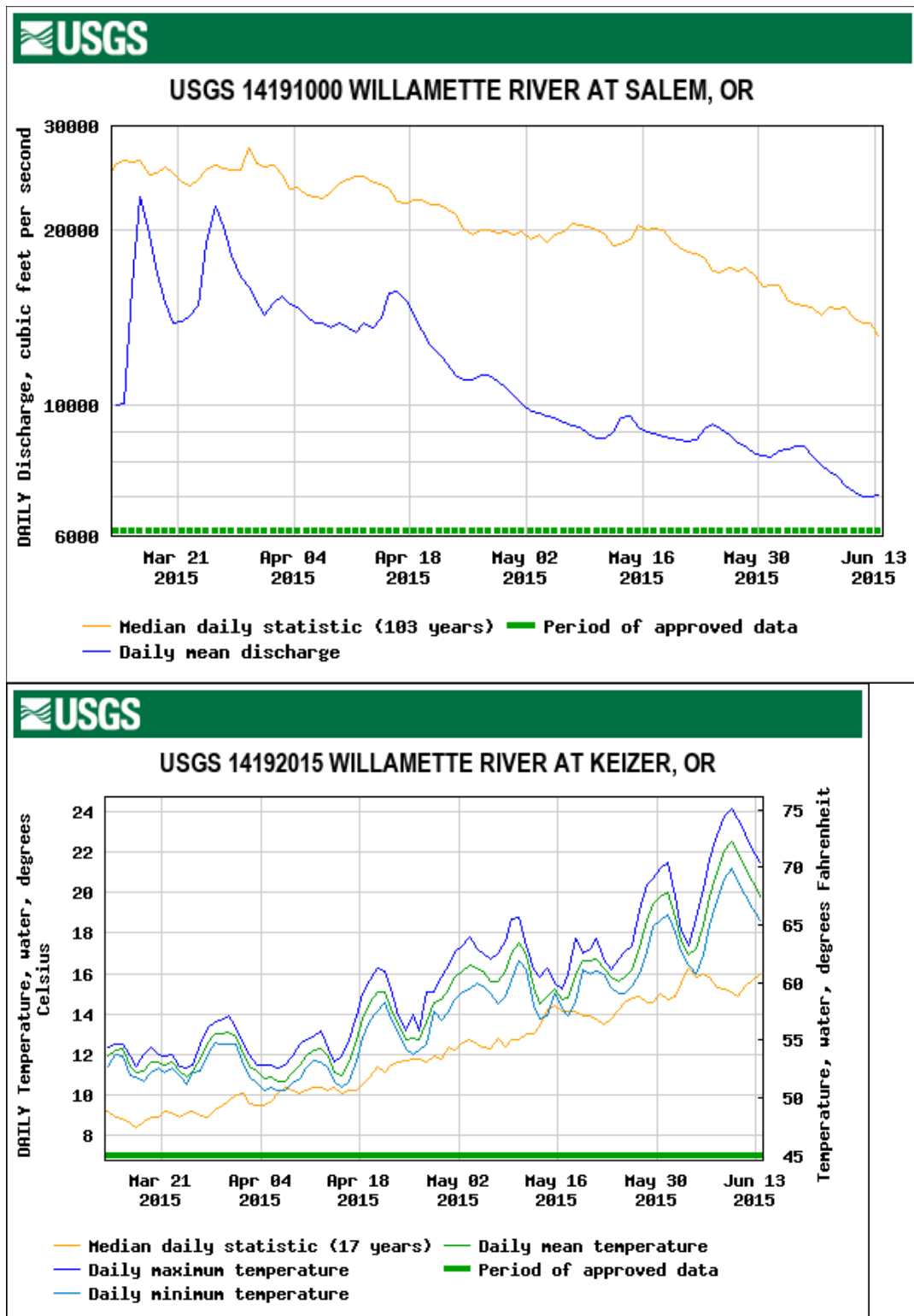


Figure 2.5-2 Changes in flow at Salem, top; and temperatures at Keizer, 3 miles downstream.

UWR Chinook salmon and steelhead

Tributary flows in the Santiam Basin

The proposed allocation of water in some tributaries will lead to reduced instream flows, with proposed diversions large enough to affect the habitat conditions. In the North, South, and mainstem Santiam Rivers, where the two core populations of UWR Chinook salmon and steelhead spawn and rear, proposed allocations will lead to increased diversions for mostly for irrigation (Figure 2.1-2 shows approximately 15% of the total AI diversions in the Santiam Basin reaches, labeled 2, 3, and 4). The diversions shown for the North Santiam, ranging from 110 to 213 cfs in July (Appendix G, USACE 2018b) will affect water temperatures, in some cases affecting current reservoir operations to manage temperatures at dam outlets. Where air temperature and mass of water dominate, larger diversions will cause increased temperatures (Rounds 2017) when downstream of the reaches that are dominated by release temperatures. They could also dewater off channel areas used by rearing juvenile UWR Chinook salmon and steelhead. Currently, diversions near Geren Island in the North Santiam are approximately 400 cfs during summer months, leaving 600-800 cfs during June- August low flow periods with minimum flow objectives of 1000 cfs to 1200 cfs (NMFS 2008a). The same reach may have increased diversions where contracts add to existing diversions. The combined effect of allocations allowing new diversions in the Santiam Basin along with current low flow summer conditions, and climate change air temperature increases, will reduce the suitability of this habitat for rearing juveniles.

In modeling VSP for UWR Chinook and UWR steelhead populations Zabel et al (2015), focused on evaluating downstream passage options. However, they also addressed future efforts to change hatchery influence, pre-spawning mortality, egg viability, and capacity estimates. For effects from diversions changing temperatures, changes in egg viability is notable for the “potentially equally important [] effect of non-lethal temperature levels or levels of contaminants on the viability of gametes” (p. 2.21). Discussing capacity estimates for other than spawner–egg life stages (primarily used to populate the life cycle model density dependence), Zabel et al (2015) noted: “rearing capacities may be limiting in some reaches, but were not available for inclusion in the SLAM model...Capacity limits may be different for different age classes, in part due to the degree to which either resource (food) limitations, social interactions, or refuge habitat (refuge from flow events and/or thermal extremes) control juvenile density.” Thermal extremes would be more likely to affect juvenile density when the increased diversions create areas of warmer temperatures.

All rearing juveniles spend some time in the tributary mainstem before migrating to the Willamette River, and this life history stage will be affected. Primarily, outmigrating juvenile steelhead will be affected due to conditions in the mainstem of the Santiam Rivers and the mainstem Willamette. Rearing juvenile Chinook salmon in the Santiam basin will see most effects before leaving as subyearlings or yearlings. The effect will compromise the ability of these populations to recover from current historic lows due to new diversions resulting from the proposed allocations.

UWR Chinook salmon and steelhead species summary

The life cycle model conclusion from Zabel et al (2015) for the North Santiam steelhead population was a low VSP score, based on a relationship between VSP score and abundance and productivity for the baseline conditions. The median North Santiam steelhead VSP score was 1.9 with a total VSP score (incorporating diversity and spatial structure) of 2.1. For the South Santiam steelhead population, the VSP score for abundance and productivity in the baseline was slightly better at 2.5; with a total VSP score of 2.6. Both of these populations have seen drastic reductions in abundance in recent years, and the potential effects on juveniles from the proposed actions would further harm the potential for recovery by reducing abundance and productivity of juveniles.

For the four UWR Chinook salmon affected by the proposed action, the baseline total VSP scores ranged from estimates of 0.3 for the Middle Fork population, 2.7 for the McKenzie population, 0.3 for the South Santiam population and 2.6 for the North Santiam population (Zabel et al. 2015). Due to the proposed action, UWR Chinook adults would be affected by warmer temperatures during migration, leading to higher prespawn mortality levels that would reduce their abundance and productivity.

In conclusion, abundance and productivity of UWR Chinook salmon will be reduced significantly by the proposed action re-allocating storage which leads to increased diversions affecting all populations in the mainstem above Willamette Falls. For UWR steelhead populations, abundance and productivity will be significantly reduced due to warming during low flow outmigration periods in the mainstem Willamette River. In the Santiam basin, core populations of juvenile Chinook salmon and steelhead will also be affected by reduced rearing habitat quality and availability. These affects will lead to reduced VSP levels of abundance and productivity, which are crucial elements in overall VSP scores. Spatial structure and diversity are less likely to change noticeably as a result of the proposed action.

Other Columbia Basin salmon and steelhead species

Species that occur between Willamette Falls and the confluence of the Willamette River with the Columbia River include:

- LCR Chinook salmon
- LCR coho salmon
- LCR steelhead
- UCR Chinook salmon
- UCR steelhead
- MCR steelhead
- SR spring/summer Chinook salmon
- SR fall Chinook salmon
- SR sockeye salmon
- SR steelhead
- CR chum salmon.

These species may be present during juvenile or adult life history stages and use the lower Willamette River near the mouth for rearing and holding. These species would be harmed by reduced flows because of increased AI and M&I diversions below Salem as a result of the proposed action. Currently, the WVS maintains minimum flows at Salem to meet NPDES standards, and maintains spring flows at Willamette Falls of around 15,000 cfs to provide safe passage for steelhead smolts. Under lower flow conditions, access to off-channel habitats could be reduced, the large nutrient loads from the Willamette River being discharged into the Columbia River (NMFS 2011b) would be more concentrated, and temperatures would be increased. However, these species would only be exposed to very small adverse effects of the action due to the controlling influence that ocean tides and Columbia River dam operations exert on river flow and water temperatures below Willamette Falls and beyond. In addition, the effects of the proposed action are limited below the Willamette Falls due to flows from the Clackamas River and other tributaries, above the confluence with the Columbia River. Inputs from these tributaries would further minimize flow effects associated with the proposed action.

Although the proposed action's increased diversions that reduce instream flows would likely limit habitat quality near the confluence of the Willamette and Columbia rivers, this effect would be small and overshadowed by ongoing land use development activities and Columbia River flows.

The proposed action may harm individual fish by further degrading rearing and holding habitat, but not to the extent that it would cause effects at the population level for any of these eleven ESUs/DPSs. The effects of the proposed action on flows below Willamette Falls are attenuated by other hydrologic inputs, and the salmon and steelhead species that do not migrate above the falls are not likely to be exposed to reduced flow conditions for very long as they migrate through the action area. Because the duration of individual exposure is low, and because the flow effects on habitat and water quality are limited in this reach, the percentage of the populations listed above that might be affected by changes in habitat is likely very low. We expect the effects of the proposed action to only slightly reduce abundance and productivity of these species.

2.5.2 Effects of the Proposed Action on Designated Critical Habitat

Mainstem Critical Habitat

The mainstem Willamette River from its mouth to its origin at the confluence of the Middle Fork and Coast Fork at RM 187 has been designated as critical rearing/migration habitat for UWR Chinook salmon and UWR steelhead. The 2008 RPA minimum flows will be reduced by proposed action, particularly below Salem and in the Santiam Basin, affecting downstream migratory habitat of juvenile salmonids during late spring. In particular, UWR Chinook salmon from the Middle Fork Willamette River and McKenzie River populations, and UWR steelhead and Chinook salmon North Santiam and South Santiam populations will be affected. Similarly, the minimum mainstem flows provide beneficial habitat for upstream migration of adult UWR Chinook salmon and UWR steelhead during spring and summer months. Changes to minimum flows for the mainstem Willamette would affect rearing and migration habitat by reducing summer water quality (increased water temperatures, reduced dissolved oxygen, and higher concentrations of pollutants). For critical habitat designated for spawning and incubation,

changes in mainstem flows from the proposed allocation leading to increased diversions would have no effect on these life history stages, as the habitat for these are not in the mainstem.

Designated critical habitat within the action area for the ESA-listed Chinook salmon and steelhead considered in this opinion consists of freshwater rearing sites and freshwater migration corridors and their essential physical and biological features (PBFs) as indicated in Table 2.5-4. The effects of the proposed action on these features are summarized, and most were discussed above as habitat-related effects of the action.

Table 2.5-4 Effects of the proposed action on Critical Habitat in the Mainstem Willamette and Santiam River subbasins.

Physical / biological features (PBFs)	Pathway	Indicator	Effects on PBFs
Freshwater rearing sites Freshwater migration corridors	Water quality	Temperature	Reduced mainstem flows, increase temperature that adversely affects rearing and migration habitat
Freshwater rearing sites Freshwater migration corridors	Water quality	Dissolved oxygen (DO)	Reduced DO in lower Willamette resulting from lower summer flows
Freshwater rearing sites Freshwater migration corridors	Water quality	Chemical contamination/nutrients	Higher concentrations with lower flows.
Freshwater rearing sites Freshwater migration corridors	Water quantity: flow/hydrology	Change in peak/base flow	Reduce freshwater rearing habitat in the mainstem that is seasonally important. Reduce suitability of migratory corridor.

Critical Habitat in the Tributaries

In the tributaries that serve as rearing, spawning, and migratory habitat, critical habitat designated for spawning and incubation would likely be affected by reduced flows from new diversions in the Santiam Basin, while most of the diversions are primarily proposed for mainstem flows (91.6% of M&I and 59.1% of AI, see maps in Analytical Approach, Section 2.1). These mainstem diversions would likely have little effect on tributary critical habitat PBFs.

However, as the 2008 RPA noted, for BOR permits issued after BiOp flow objectives were established, diversions would not be provided by Corps dams when flow objectives are missed because partial or no supply is available. If flow objectives are met, water would be removed from the Willamette River and its tributaries during the irrigation season without any additional water being released for existing contracts. Such flow reductions could affect juvenile Chinook salmon and steelhead rearing habitat in the affected stream reaches.

For the new diversions from the proposed allocation in tributaries for either BOR or Corps contracts, the proposed action indicated that increased releases from the reservoirs in the

tributaries would be provided downstream from the reservoirs. If this is the case, the effects of the proposed action on critical habitat in the tributaries would be similar to existing effects of flow and temperature operations during the May through October months from the 2008 Biological Opinion. The exception would be for the larger diversions proposed for allocations in the Santiam River, primarily in the North Santiam, which would see effects on freshwater rearing critical habitat as described in the Table 2.5-4, above, and in the effects to the species.

The North and South Santiam Rivers have been designated as critical habitat for UWR Chinook salmon and UWR steelhead. The PBFs identified in this critical habitat include sites for spawning, rearing, and migration. The quantity and quality of freshwater rearing sites for juvenile UWR Chinook salmon and UWR steelhead will remain limited and degraded in the fully accessible portion of the South and North Santiam River below Project dams, and may continue to decline. Diminished flows contribute to losses of off-channel rearing habitat. Reductions in outflows below Project dams will, when flows are relatively low, continue to pose risks of juvenile stranding and loss.

In aggregate, these effects will continue to diminish habitat availability and suitability within the North and South Santiam subbasins for juvenile and adult UWR Chinook salmon and UWR steelhead. These adverse effects to the functioning of designated critical habitat within the subbasin will limit the habitat's capacity to serve its conservation role supporting large, productive, and diverse populations of these fish.

Critical Habitat in the Lower Willamette and Lower Columbia

As described above, increased water diversions below Salem as a result of the proposed action, and resulting reduced flows in the lower Willamette River, are likely to have negative effects on water quality. Current flows provided at Salem for water quality would be reduced as diversions were withdrawn downstream, resulting in less dilution of contaminants and increased water temperatures, particularly when air temperatures are high. Proposed changes to Willamette Project flow operations could reduce the quantity and quality of rearing habitat in the lower river, estuary, and plume, including critical habitat. Adverse effects of the action on the 11 Columbia River species (listed above in Section 2.5.1 Effects) will also affect habitat, by very small decrease in average monthly flows in the lower Columbia River and estuary during the peak diversion period, resulting in "slight to negligible" effects on habitat conditions, including the PBFs for freshwater migration corridors and freshwater rearing corridors.

However, as described above inputs from tributaries below Willamette Falls and influences from the Columbia River and ocean tides will minimize the magnitude of these changes. For critical habitat designated for salmon and steelhead species between the Willamette Falls and the confluence of the Willamette and Columbia Rivers, the Proposed Action's increased diversions would likely have a very small effect on the function of PBFs in rearing and migration habitat in the lower Willamette below the Willamette Falls, including habitat near the confluence of the Willamette and Columbia rivers.

2.6 Cumulative Effects

“Cumulative effects” are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area’s future environmental conditions caused by global climate change that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the Environmental Baseline (Section 2.4).

Information presented by the Corps in Section 8 of the Biological Assessment (BA) (USACE 2018a) described four types of cumulative effects: “past, present, and reasonably foreseeable actions,” nonpoint source pollution and water quality, climate change, and recovery actions at Fern Ridge Lake.¹¹

Under the heading of nonpoint source pollution and water quality, the BA described runoff from irrigated agriculture and urban development within the action area as a concern for UWR Chinook salmon and steelhead. Citing from a list of nonpoint pollution sources that was provided in the Middle Willamette Agricultural Water Quality Management Area Plan (ODA 2016), the BA attributed unquantified temperature impacts to wastewater treatment plants, industrial operations, removal of riparian vegetation, seasonal reductions in stream flow, and stream channel and floodplain alteration. Similarly, the BA noted that many actions contribute to bacteria and nutrient concerns, including wastewater treatment plant overflows during heavy rains or generalized leaching to groundwater, legal and illegal waste dumping sites, leaching septic systems, leaching of fertilizers to groundwater, runoff from urban and rural areas and roads, runoff from agricultural lands, and natural sources such as geese and other wildlife as contributors to bacteria and nutrient concerns (ODA 2016). The BA cited ODA (2016) to say that mercury can enter waterbodies from industrial and municipal wastewater discharges, erosion of soils that naturally contain mercury, runoff of atmospherically deposited mercury, and runoff from abandoned mines. Any of these impacts occurring in the future would be considered cumulative effects.

NMFS also found that ODA (2016) identified strategies to prevent and control water pollution caused by runoff from agricultural lands through a combination of outreach programs, suggested land treatments, management activities, compliance, and monitoring that ODA deems necessary

¹¹ Each of the nine actions or programs listed in the BA as “past, present, and reasonably foreseeable” are Federal actions, as are recovery actions at Fern Ridge Lake. As noted in the definition of cumulative effects above, Federal actions are not part of the ESA cumulative effects analysis. Therefore, the anticipated effects of those actions listed in the BA that have already undergone separate consultation are discussed as part of the Environmental Baseline (Section 2.4), and the effects of those actions that will require consultation in the future will be considered at that time.

to protect designated beneficial uses related to water quality, including fish and aquatic life. However, ODA also specified that the Middle Willamette Agricultural Water Quality Management Area Plan is neither regulatory nor enforceable (ODA 2016). Any beneficial impacts from these programs are not reasonably certain to occur and are not considered cumulative effects.

The discussion in the BA of nonpoint source pollution and water quality also described watershed modeling by the USEPA (2013) that assessed the sensitivity of streamflow, nutrient, and sediment loads to potential climate change and urban development in twenty different watersheds, including the Upper Willamette River. The EPA's model projected that, under moderate climate change scenarios, future changes in urban and residential development as of the year 2070 are likely to increase total suspended solids, total phosphorus, and total nitrogen by less than 5 percent at the confluence of the Willamette and Columbia Rivers. However, USEPA (2013) also noted that it did not consider changes in agricultural practices, human use and management of water, other human responses, or natural ecosystem changes such as the prevalence of forest fire (Westerling *et al.* 2006) or plant disease that will also influence streamflow and water quality during the period of interest.

Climate change has been described extensively in the baseline section above. NMFS cannot distinguish climate change effects that have already been set in motion and would meet the definition of baseline effects, versus future climate change effects which would be described in this section. For the purposes of NMFS' Opinion, this is not an important distinction; NMFS will consider past, present and predicted future effects of climate change in our determination. It is likely that some future non-Federal activities within the action area are reasonably certain to contribute to climate effects within the action area. However, those effects cannot be distinguished from the impact of regional or global climate change that are discussed as part of the Environmental Baseline (Section 2.4) or Status of Species and Critical Habitat (Section 2.2).

Nonetheless, it is worth mentioning that the BA's discussion of climate change as a cumulative effect cited CIG (2010), OCCRI (2015), Corps (2017), Dalton et al. (2017), and Jaeger et al. (2017) to conclude that maximum temperatures within the action area will increase, especially in summer, the seasonal distribution of precipitation will skew more heavily toward winter, and snowpack will be dramatically reduced, although no consensus exists regarding the magnitude of these trends at the regional level. Further, the Corps estimated that climate induced reductions in live stream flow will require an additional 160 thousand acre feet (KAF) per 20 year increment (on average) to meet minimum flow objectives as often as they are currently (USACE 2017).¹²

Jaeger et al. (2017) includes many key finding regarding effects of future state or private activities that are reasonably certain to occur within the action area in addition to those mentioned in the BA, including the following (some findings were edited or deleted for brevity):

¹² Despite the lack of consensus on the magnitude of climate change to be expected, the Corps did not incorporate this forecasted increase in the demand for F&W.

Water Supply

- A severe decline in snowpack in the next 80 years combined with higher temperatures is expected to increase stress on upland forests and increase the risk of wildfire by 200 to 900 percent, thus reducing evapotranspiration and allowing more surface water to flow into the Willamette Valley.

Water Use

- Water use is influenced by both the demand (willingness to pay) for water and the cost of transporting, storing, or transforming water for a given use. Cost is critical because demand for transported water depends on the value of the water for a specific purpose.
- For example, water is transported up to 25 miles from outside the Willamette Basin, often aided by gravity, for urban use. In contrast, 0.25 miles of horizontal or uphill conveyance can be costly enough to make delivery for AI uneconomic on most currently unirrigated agricultural lands in the Basin. That is why one-third of the farmland with irrigation water rights goes unirrigated each year. In some years and on some lands, the cost of irrigation outweighs the benefit.
- Water use for AI in the Willamette Valley fluctuates from year to year, but shows no significant upward trend in recent decades. The per-acre amount of water required for irrigation is expected to remain relatively stable, although seasonal patterns of AI are likely to shift about 2 weeks earlier in response to earlier planting dates resulting from climate change.
- The potential use of stored water to expand irrigation to farmlands that currently do not have irrigation water rights is limited by economic realities; conveyance costs are high relative to the economic gain from irrigating.

Water Scarcity

- In some parts of the WRB and at some times of year, water is scarce, and that scarcity is likely to increase in the future. The potential for increased water scarcity will be location- and time-specific. Our model results suggest the following:
- The municipal water rights currently relied upon may reach capacity in the Portland Metro area (in 30 years) and in Salem (in 60 years). However, when the model accounts for currently underutilized water rights and those under development, urban water rights appear to be capable of meeting the overall growth in urban water demand.
- Climate change is projected to result in earlier planting for agriculture. Earlier planting will lead to more crop growth during the months when temperatures are cooler and soil moisture is more available. Earlier planting will also lead to an earlier start, and completion, of irrigation. In the future, more farmers will have finished irrigating by the time the threat of a shutoff arises, according to the model results.
- As a result, the model shows a slight decrease in irrigation shutoffs. Climate models differ, however, in terms of whether precipitation is predicted to increase or decrease overall, although most models suggest somewhat wetter winters and drier summers.
- Implementation of all of the “unconverted” in-stream water rights intended to protect perennial flows would represent a significant increase in the amount of water allocated

under state law to environmental values. Overall, however, our results suggest that flow requirements to protect salmon and steelhead can be met, based on 10-year average flows. Exceptions are likely to occur in drought years.

- The effects of changes in forest wildfires and fire suppression policies could have a larger effect on water supply in the Valley than all of the changes in human water use combined. If forest cover is dramatically reduced, the resulting decrease in forest evapotranspiration will increase streamflows and make more water available for human use.

Other research, such as Bartlett et al. (2004), showed that variation in the onset time and duration of seasonal snow events can also significantly reduce the effect of solar radiation on surface ground temperature. However, Sharma et al. (2018) reviewed monitoring data to show that increased air temperature leads to drier soils, more soil evaporation, and less runoff for rivers, even when total rainfall increases. While decreased forest coverage can potentially increase streamflow, it is most likely to be seen at peak runoff, and less available as groundwater that replenishes low flows.

Regarding the issue of whether the State of Oregon is likely to take action that will provide the legal protection that it and others have suggested to protect stored water that the Corps proposed to release for the benefit of F&W uses, such action is entirely speculative. This conclusion is based on the facts that the State currently lacks sufficient legal authority to take such action; no plan, budget, or appropriation for the work necessary to complete that action; and no successful precedent for that action (Woodcock and McCord 2018).

2.7 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) Reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminishes the value of designated or proposed critical habitat for the conservation of the species.

In the rangewide status of the species and critical habitat (Section 2.2), we showed that 13 ESA-listed species occur within the action area. Of those, only UWR Chinook salmon and UWR steelhead occur above the Willamette Falls and will be exposed to significant adverse effects of the proposed action. Species that occur between Willamette Falls and the confluence of Willamette River with the Columbia River will only be exposed to very small adverse effects of the action due to the controlling influence that ocean tides and Columbia River dam operations exert on river flow and water temperatures below Willamette Falls and beyond. Those species include SR fall-run Chinook salmon, SR spring/summer-run Chinook salmon, Snake River Basin steelhead, SR sockeye salmon, UCR spring-run Chinook salmon, LCR Chinook salmon, LCR

Steelhead, MCR steelhead, UCR steelhead, CR chum salmon, and LCR coho salmon. Therefore, only UWR Chinook salmon and UWR steelhead will be further discussed here.

The UWR Chinook salmon ESU is comprised of seven populations. Five of those populations are at very high risk of extinction, one is at moderate risk (Clackamas River), and one is at low risk (McKenzie River). Recent data indicates the fraction of hatchery origin fish in all populations remains high, even in Clackamas and McKenzie populations. The proportion of natural origin spawners improved in the North and South Santiam basins until 2015, but is still well below identified recovery goals. Abundance levels for five of the seven populations remain well below their recovery goals. Of these, the Calapooia River may be functionally extinct and the Molalla River remains critically low. UWR Chinook salmon returning to Willamette Falls showed a downward trend in natural origin adult returns from 2010-2018. In the four historically most productive east-side tributaries, access to historical spawning and rearing habitat is restricted by large dams, confining natural origin UWR Chinook salmon to more lowland reaches with less suitable water quality and habitat until effective passage programs are in place. Overall, this species is at high risk of extinction, although these limiting factors in addition to current climate conditions and the prospect of long-term climate change may put this ESU at very high risk in the near future.

Regarding UWR steelhead, we showed that this species has four demographically independent populations, and that three populations are at low risk and one population is at moderate risk. Declines in abundance noted in the last status review continued through the period from 2010-2015. This DPS continues to demonstrate the overall low abundance pattern that was of concern during the last status review. The causes of these declines are not well understood, although much accessible habitat is degraded and under continued development pressure, and the species appears to be increasingly influenced by pinniped predation at the base of Willamette Falls. The elimination of winter-run hatchery release in the basin reduces hatchery threats, but non-native summer steelhead hatchery releases are still a concern for species diversity and a source of competition for the DPS. While the collective risk to the persistence of the DPS has not changed significantly in recent years, continued declines and potential negative impacts from climate change may cause increased risk in the near future.

We also showed that critical habitat designated for UWR Chinook salmon encompasses ten subbasins in Oregon containing 56 occupied watersheds, as well as the lower Willamette/Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some, or high, potential for improvement. Watersheds in good to excellent condition with no potential for improvement are only present in the upper McKenzie River and its tributaries. We rated conservation value of HUC5 watersheds as high for 22 watersheds, medium for 16 watersheds, and low for 18 watersheds. Specific geographic areas of concern for UWR Chinook salmon include dams and reservoirs in the four historically most productive tributaries, which are the North Santiam, South Santiam, McKenzie and Middle Fork Willamette populations.

Critical habitat designated for UWR steelhead encompasses seven subbasins in Oregon containing 34 occupied watersheds, as well as the lower Willamette/Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or

fair-to-good condition. However, most of these watersheds have some or a high potential for improvement. Watersheds in good to excellent condition with no potential for improvement occur only in the upper McKenzie River and its tributaries. We rated conservation value of HUC5 watersheds as high for 25 watersheds, medium for 6 watersheds, and low for 3 watersheds. For both UWR species, critical habitat boundaries include the stream channels, extending laterally to the ordinary high-water line, or bankfull elevation, where ordinary high-water line has not been defined.

In the environmental baseline (Section 2.4), we noted that the Willamette Basin is home to 70 percent of Oregon's human population, including Oregon's three largest cities (Portland, Eugene, and Salem). Moreover, approximately 64 percent of the Basin is in non-Federal ownership, with 34 percent in non-Federal forest use, 22 percent in agricultural production, 8 percent in urban or in other uses. More than 90 percent of the valley floor is privately owned. We also cited the UWR Recovery Plan for Chinook Salmon and Steelhead to note that an altered hydrograph and reduced water quality, including changes the quantity and timing of instream flow and related habitat impacts, that are due in large part to water withdrawals, wastewater runoff and discharge from agricultural and urban land uses, are habitat-related threats limiting the recovery of both UWR Chinook salmon and UWR steelhead. According to publications by the OSU Extension Center, water use in the Willamette Valley, as elsewhere, is influenced by both the demand (willingness to pay) for water and the cost of transporting, storing, or transforming water for a given use. Because of these factors municipal water use constitutes only a small portion of water use in the basin, with much larger consumptive use being withdrawn for agricultural irrigation.

UWR Chinook salmon and UWR steelhead in the action area have been adversely affected by continued existence and operation of dams, including those in the WVS, which blocked habitat access, altered downstream flows and water quality, eliminated transport of sediment and wood, and inundated riverine habitat. Downstream from the dams, habitat was further degraded by water diversions, agricultural and urban run-off, channel hardening and floodplain disconnection. Of those factors, the ones most related to this proposed action are water quantity, and quality. Construction and operation of the WVS to capture and hold flow for later release has altered the timing of those flows in relation to critical salmon and steelhead life history events. Corps releases to meet the 2008 RPA Salem flow targets were below the minimum objectives for 60% of years deemed adequate in the last decade. The targets were missed during the same months that the proposed allocation would increase diversions by M&I and AI users.

Similarly, construction and operation of the WVS has altered water temperatures in the Willamette Basin through storage, diversion, and irrigation return flows. Typical WVS operations release stored water in the late spring and early summer that is cooler than what it would be in a riverine system, and then warmer in the fall once warm water near the reservoir surface can be discharged. Cooler water temperatures in late-spring and early summer delay upstream migration of UWR Chinook salmon, and eggs from spring spawning UWR steelhead develop more slowly at reduced temperatures. For fall spawning species like UWR Chinook salmon, warmer fall temperatures change migration timing and accelerate incubation, and can exceed the thermal tolerance for incubating eggs, thus reducing their viability, and also increase thermal stress on adults holding below the dams.

In the effects of the action (Section 2.5), we showed that the impact of diversions from the mainstem of the Willamette River to meet new secondary water rights to use stored water that the Corps proposed to release for M&I and AI uses is likely to reduce flows below Salem sufficiently to increase water temperature during dry years by 0.2°C to 0.8°C, and during average (i.e., mid-range adequate) flow years from 0.1°C to 0.8°C. This, in turn, is likely to affect adult UWR Chinook salmon migrating in the reach between Willamette Falls and the Santiam River sufficiently to increase the incidence of pre-spawn mortality, one of the main factors contributing to the high risk determination for this species. This effect will be compounded by the increase in summer air temperatures and lower flows expected under climate change.

The timing of the adult UWR steelhead migration makes them less vulnerable to changes in mainstem flows caused by mainstem diversions. However, the timing of juvenile UWR steelhead outmigration makes this life history stage vulnerable to higher water temperatures during spring and summer, partially due to the effects of parasitic myxosporean, *Ceratomyxa shasta*, which becomes highly virulent when water temperatures exceed 15 °C during outmigration, as becomes more likely if filling the conservation pool for AI or M&I use is given a higher priority than spring flow targets. Similarly, the Corps' proposal to allow increased diversion of stored water commensurate with developing demands in the North and South Santiam Rivers, including approximately 15% of the total projected AI demand, changes the provisions of the 2008 BiOp RPA which block new AI contracts in the North and South Santiam Rivers to protect already overextended flows necessary to sustain spawning and rearing for critical populations of UWR steelhead.

Similarly, we also showed that the effects of the proposed action due to reduced water quantity, water quality (including increased water temperatures, reduced dissolved oxygen, and higher concentrations of pollutants), will reduce the conservation value of critical habitat designated for UWR Chinook salmon for adult freshwater migration and spawning, embryo incubation, and juvenile growth and development. Those same effects will reduce the conservation value of critical habitat designated for UWR steelhead for adult spawning and juvenile growth and development.

The proposed action will significantly reduce abundance and productivity of most UWR Chinook salmon and steelhead populations, with the exception of the Clackamas River spring-run Chinook. UWR Chinook salmon will be affected by increased diversions from tributaries and the mainstem Willamette River affecting all populations above Willamette Falls. For UWR steelhead populations, abundance and productivity will be significantly reduced due to effects on juvenile life history stages in the mainstem and tributaries. Spatial structure and diversity will be less likely to be affected.

In the cumulative effects (Section 2.6) we noted that population growth will increase water demand for cities, although water demand for agriculture is likely to remain relatively constant in the absence of a new inexpensive source of water. Growing cities are likely to displace irrigated farmland as legal and economic constraints limit the development of new irrigation projects. Urban consumptive use in the Willamette Valley from in-basin surface water sources is projected to increase by about 16 KAF by 2100, due primarily to population growth, but also to rising income, although this growth will be also tempered by recent and near-term price increases

related to cost recovery for infrastructure investment related to the cost of water and wastewater services. The municipal water rights currently relied upon to meet urban demand in the Willamette Valley may reach capacity in the Metro area in 30 years and in Salem in 60 years, although when currently underutilized water rights are accounted for along with those already under development, urban water rights appear to be capable of meeting the overall growth in urban water demand.

Unfortunately, strategies identified by the Oregon Department of Agriculture in the Middle Willamette Agricultural Water Quality Management Area Plan to prevent or control water pollution caused by runoff due to agricultural practices are neither regulatory nor enforceable. Similarly, the Oregon Water Resources Department currently lacks sufficient legal authority and other resources to necessary to designate or protect stored water that the Corps proposes to release from the WVS for the benefit of fish and wildlife as instream flow.

In each of the above sections, as appropriate, we explained how our changing climate is likely to affect the species and critical habitats at a broad scale that is distinct from natural climatic variability; how climate change has already affected the environmental baseline in the Willamette Valley so that we can no longer assume current environmental variability adequately describes environmental baseline conditions, and how climate change is likely to amplify the effects of the action by overlapping with adverse impacts to the timing and quantity of instream flow, and the temperature of those flows. We also explained that while it is likely that some future non-Federal activities within the action area are reasonably certain to contribute to climate effects within the action area, those effects cannot be distinguished from the impact of regional or global climate change.

In summary:

1. We issued a jeopardy biological opinion and RPA on the WVS in 2008. Full implementation of the RPA in the 2008 biological opinion was expected to avoid jeopardy and adverse modification of critical habitat.
2. The Corps has implemented parts of the RPA, but key elements of the RPA remain in process, including the installation of a temperature control tower at Detroit Dam on the North Santiam and establishment of downstream fish passage at several WVS dams.
3. Both species remain at high risk as they continue to experience the adverse effects caused by operation of the WVS without full implementation of the RPA.
4. The status of both species has declined since 2008.
5. The proposed action will reduce population abundance and productivity for UWR Chinook salmon and UWR steelhead
6. The proposed action would result in additional adverse effects associated with operation of the WVS on UWR Chinook salmon, steelhead, and their critical habitat.
7. The proposed action would limit the Corps' flexibility to comply with the 2008 BiOp and RPA provisions that are still incomplete, as well as ESA Section 7(d) requirements in relation to the separate reinitiation of the 2008 BiOp now underway.

After we add the effects of the action to the environmental baseline and the cumulative effects, taking into account the status of the species and critical habitat, we conclude that the proposed

action will appreciably reduce the likelihood of both the survival and recovery of UWR Chinook salmon and steelhead in the wild by reducing their numbers, reproduction, or distribution. We also conclude that the proposed WBR appreciably diminishes the value of designated critical habitat for the conservation UWR Chinook salmon and steelhead.

2.8 Conclusion

After reviewing and analyzing the current status of the listed species (high risk for UWR Chinook salmon and moderate risk for UWR steelhead, respectively) and critical habitat (degraded), the environmental baseline (degraded) within the action area, the effects of the proposed action (primarily decreased flows and increased temperature), any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the proposed action is likely to jeopardize the continued existence of UWR Chinook salmon and UWR steelhead and destroy or adversely modify their designated critical habitats.

We also conclude that the proposed action is not likely to jeopardize the continued existence of LCR Chinook salmon, UCR spring-run Chinook salmon, Snake River spring/summer run Chinook salmon, Snake River fall-run Chinook salmon, Columbia River chum salmon, LCR coho salmon, Snake River sockeye salmon, LCR steelhead, MCR steelhead, UCR steelhead, Snake River Basin steelhead, or adversely modify their designated critical habitats. As further explained below, we also conclude that the proposed action is not likely to adversely affect Southern Resident Killer Whales.

2.9 Reasonable and Prudent Alternative

“Reasonable and prudent alternative” (RPA) refer to an alternative actions identified during formal consultation that can be implemented in a manner consistent with the intended purpose of the action, that can be implemented consistent with the scope of the Federal agency's legal authority and jurisdiction, that are economically and technologically feasible, and that would avoid the likelihood of jeopardizing the continued existence of listed species or resulting in the destruction or adverse modification of critical habitat (50 CFR 402.02).

In Section 2.8, NMFS concluded that the Proposed Action would jeopardize the continued existence of UWR Chinook salmon and UWR steelhead, and destroy or adversely modify their designated critical habitat. Therefore, NMFS is providing the Action Agencies with the following RPA to avoid jeopardizing the continued existence of UWR Chinook salmon and UWR steelhead, and avoid destroying or adversely modifying their critical habitat, as required by ESA section 7(b)(3)(A).

The five measures NMFS is providing here fit the regulatory requirements of an RPA and include:

2.9.1 RPA MEASURE 1

When the Portland District of the US Army Corps of Engineers (Corps) submits its final feasibility report regarding the proposed reallocation of conservation storage space in the WVS, it will include a recommendation that the Corps will retain sufficient local authority to modify that reallocation without further Congressional action, as necessary to complete all actions related to the storage and release of water from the WVS that are already called for in NMFS (2008a), any biological opinion that will be issued as a result of reinitiation of the NMFS (2008a) consultation, and any biological opinion that may be issued as the result of a future ESA consultation related to the storage and release of stored water from the WVS.

2.9.2 RPA MEASURE 2

The Corps will defer entering into any new water storage contracts for municipal and industrial (M&I) use beyond a total of 11 thousand acre-feet (KAF)¹³ until NMFS issues its written agreement to the Corps and the Oregon Water Resources Department (OWRD) that:

1. OWRD has developed and implemented the institutional mechanisms and infrastructure (including legal, financial, human, and technological resources) necessary to carry out a plan for instream flow protection in the Willamette Basin.
2. The plan has been fully implemented in a manner consistent with Federal and State law.
3. Any secondary water rights applied for by the Oregon Department of Fish and Wildlife (ODFW) have been certificated by the OWRD consistent with the full amount of water allocated for F&W use.¹⁴

¹³ This volume is derived from the deficit forecast for 2030 described as the “difference between future demand for water and the future reliable supply of water” (USACE 2018b). That amount has been adjusted here to estimate unmet need that is expected to materialize by 2025. Similarly, US Bureau of Reclamation (BOR) has an existing 95,000 acre-feet limit on storage contracts until reinitiation of the NMFS 2008 biological opinion on the WVS is completed. In this RPA we assume BOR will adhere to this limit until NMFS’ written agreement described here has been issued.

¹⁴ NMFS intends to provide written agreement when steps 1 through 3.3 (below), or similar steps that produce equivalent instream flow protections for fish and wildlife, are completed. The process includes the following:

1. The ODFW, NMFS, the Corps, and other water quality and fish management partners will determine mainstem and tributary flow targets for State instream protections.
2. Instream Protection:
 - 2.1. The State of Oregon (State) will change the character of use for water right storage certificates issued to the BOR to include agricultural irrigation, municipal and industrial, and fish and wildlife uses.
 - 2.2. The State and the Corps will enter into an agreement consistent with Federal and State law to allow for the minimum perennial streamflows (MPSF) conversions and protections of those flows, and any additional stored water component, referred to here as secondary instream water rights (ISWR).
 - 2.3. OWRD and ODFW will:
 - a. Determine the combination of MPSF and secondary ISWRs necessary to meet the instream flow needs throughout the Willamette Valley Project.
 - b. Determine reach delineation and live and stored components for MPSFs and secondary ISWRs.
 - c. Convert the MPSF (OWRD), and apply for (ODFW) and certificate (OWRD) instream water rights, based on targets defined above, including the full allocation of stored water for fish and wildlife.
 3. Monitoring and enforcement:
 - 3.1. OWRD will develop and implement the institutional mechanisms necessary to administer water rights and flow protections for allocated water in a manner consistent with Federal and State law.
 - 3.2. The Corps will install and maintain measuring devices, as necessary, to assist OWRD.

2.9.3 RPA MEASURE 3

When the Corps enters into a new water storage supply agreement for M&I uses in the WVS, the agreement will specify restrictions, some of which are equivalent to those currently applied to new and renewed water use contracts issued by the Bureau of Reclamation (BOR),¹⁵ specifically:

1. The Corps will not issue M&I water storage agreements for water stored in the Santiam Basin until the Corps obtains written agreement from NMFS that studies necessary to determine the flow needs of ESA-listed species are complete, and that additional water is available during most years for M&I use without adversely affecting UWR Chinook salmon or steelhead, or their designated critical habitats.
2. The Corps will require M&I storage agreements to meet all of the following conditions, or ensure that secondary rights issued by OWRD for the use of that stored water will meet all of these conditions:
 - a. Compliance with NMFS fish protection criteria, including fish screens and other protections applicable to fish hazards associated presented by the M&I stored water user's water diversion practices, as approved by NMFS.
 - b. Each diversion must have a lockable headgate or equivalent device for all surface water diversions that is capable of easily starting, adjusting, and stopping the flow of water.
 - c. Diversions greater than 3 cfs must have devices to enable measurement of the instantaneous rate of water delivery, within 5% accuracy; diversions greater than 10 cfs must also have a flow totalizer that calculates total volume of water diverted.
3. The Corps must also include provisions enabling curtailment or ceasing entirely all water deliveries for M&I use in specific areas, if that water is necessary to meet flow targets established to protect listed species and their critical habitats.
4. Fulfillment of M&I storage agreements is subject to the Corps' annual operating plan for the Willamette Valley Project in which the Corps determines availability of water for those storage agreements. If the Corps determines that a shortage will occur, or is forecasted to occur, the Corps can designate this shortage to specific tributary subbasins, certain reaches, or throughout the Willamette basin, thus limiting the amount of stored water that will be made available for M&I user. In those cases, the Corps will notify M&I users of storage water shortages as described in RPA measure 9.3.4 and Appendix D of NMFS (2008a).
5. The Corps will also ensure they are meeting the Salem minimum flow objectives specified in the 2008 RPA (NMFS 2008a) and releasing additional flow to offset the amount of flow diverted by WVS M&I users with water storage supply agreements from the mainstem Willamette River below Salem.

3.3. BOR and the Corps will:

- a. Require a totalizing flow meter for measurement and reporting of water use by contract holders.
- b. Provide OWRD with near real-time information regarding contracts: status of contract--active/lapsed, contract volume, and measurement information.

¹⁵ The NMFS 2008 biological opinion and RPA (NMFS 2008a) remains in effect, and the issuance of this opinion and RPA does not amend or otherwise affect the status of the 2008 biological opinion or RPA. The Corps is continuing to implement RPA measures from the 2008 biological opinion.

Moreover, the Corps must obtain any permissions necessary to deviate from their model Water Supply Storage Agreements to ensure these conditions are included in their storage agreements in the WVS.

2.9.4 RPA MEASURE 4

The Corps must modify its proposed adaptive management process for making adjustments to reservoir operations and flow releases through proportional reduction of storage volumes among authorized project purposes so that process does not reduce the ability of the Corps to operate the WVS to meet minimum mainstem flow objectives or tributary flow objectives, as described in measures 9.2.1, 9.2.3, and 9.2.4, and Appendix D of NMFS (2008a), which are incorporated here by reference. Specifically:

1. When forecasting the available water in April of each year, the Corps must determine whether 2008 BiOp minimum flow objectives will be met in the coming year given the reservoir fill and amount of ‘joint use’ water available.
2. If NMFS (2008a) minimum flow objectives are predicted to not be met in the April forecast, the Corps must:
 - a. Manage uncontracted water to meet minimum flow objectives (NMFS 2008a or as revised by future consultations). If this is insufficient, the Corps must make more stored water available to meet 2008 BiOp minimum flow objectives. Options to achieve this may include, but are not limited to, reducing stored water available for AI and M&I contracts or using water currently stored for power production. If necessary, the Corps must obtain any additional authorization needed to re-direct water allocated or designated for other uses (e.g., power pool, AI, or M&I) in order to meet minimum flow objectives (NMFS 2008a). Management of stored water made available to meet 2008 BiOp minimum flow objectives will be coordinated with the Flow Management Water Quality Team (FMWQT).
 - b. When informing AI and M&I contract holders of their allowed proportion of contracted storage for the year, notify them that their requested water releases may be curtailed or completely cut off if the existing NMFS minimum flow objectives (2008a) are not met at any point in the coming year.
 - c. If the revised June forecast no longer indicates existing NMFS minimum flow objectives (2008a or as revised by future consultations) will be missed, available stored water will be managed consistent with existing contracts (F&W, AI and M&I).
3. If instream flows fall below 2008 BiOp (or as revised by a future consultation) minimum flow objectives at any point, the Corps must notify contract holders that a specified partial supply or no supply is available, and the Corps must curtail or completely cut off stored water releases for M&I contracts in affected tributaries, or if mainstem minimum flow objectives are not being met, in a subset of the tributaries deemed appropriate by the FMWQT. The FMWQT will determine the appropriate amount by which to reduce stored water releases for M&I contract holders. The Corps will coordinate with OWRD to ensure that diversions made by the associated M&I contract holders are being curtailed or completely cut off consistent with the reduction in stored water releases.

2.9.5 RPA MEASURE 5

The Corps must prepare an annual “Willamette Basin Year in Review Report” to document its accomplishment of the Willamette Basin Project Conservation Release Season Operating Plan (the Annual Conservation Plan) for the previous water year. The Corps must also participate in an annual coordination meeting with NMFS to discuss the annual report before finalizing an Annual Conservation Plan for the next water year. The OWRD and the ODFW must also be invited to the annual coordination meeting and provided with the opportunity to present information regarding their progress in securing instream flow protection in the Willamette Basin. Failure to submit timely annual reports or participate in annual coordination meetings may trigger reinitiation of this opinion.

The annual Willamette Basin Year in Review Report must be submitted to NMFS by end of February each year, and must include the following information (which the Corps will need to administer water released to meet new water storage agreements):

1. The estimated flow and storage needs for each WVS tributary and reservoir that were developed based on the anticipated total system storage in mid-May using the April forecast, and the final storage estimates developed in June.
2. The detailed individual project and system flow objectives, project operating drawdown priorities, and recommendations for flow shaping operations developed based on those estimates for the Annual Conservation Plan, and the specific rationale for those objectives.
3. During years identified as “deficit” years by April 1, a copy of the notice provided to the BOR and M&I storage contract holders apprising them that either (1) a specified partial supply of stored water or (2) no supply of stored water is available for the upcoming irrigation season in specific tributaries.
4. A record of adaptive management decisions made by the Flow Management Water Quality Team (FMWQT) during the conservation season and the rationale for those decisions, including each time that: (a) An authorized project purpose was reduced; and (b) Stored water releases that were modified for a specific use category.
5. Dates that each mainstem and tributary minimum flow objective was met or missed. For days minimum flow objectives were missed the magnitude of the flow deficiency should be reported as a daily or weekly average difference in cubic feet per second.
6. A summary of any other information, data, analysis, or report that the Corps, OWRD, or ODFW deems helpful to understand the previous WVS water management year.

RPA Measure 1 reduces the potential that the proposed action will result in insufficient stream flows and reductions in abundance and productivity under future conditions. This RPA measure is reasonable and prudent because it allows the Corps to go forward with a portion of its primary goal of re-allocating up to 100 percent water stored as part of the WVS water while ensuring that the Corps also retains the flexibility to comply with the 2008 BiOp RPA provisions that are still underway. It will also ensure that the Corps retains the capability to comply with ESA Section 7(d) requirements in relation to the separate consultation now underway for reinitiation of the 2008 BiOp and RPA, and for any future ESA consultations that will affect the management of water stored in the WVS.

RPA Measure 2 addresses the uncertainty of existing regulatory mechanisms to protect habitat quantity and quality for UWR Chinook salmon and steelhead. This RPA measure ensures that reductions in instream flow due to increased diversions from the water contracting program would be limited so as to not appreciably reduce the abundance or productivity of UWR Chinook salmon or steelhead prior to protection of instream flows for F&W. RPA measure 2 is reasonable and prudent because it allows the Corps to begin issuing new storage agreements for M&I uses in sufficient amounts for immediate unmet needs until 2025, while providing time the Corps needs to work with OWRD and ODFW to develop the institutional mechanisms and infrastructure to permanently protect mainstem and tributary flows required by ESA-listed species. Furthermore, new diversions from the proposed allocations will be partially offset by an increase in release of stored water. If additional releases are not provided, new diversions from these contracts will be restricted as described in RPA Measure 3. Any delay in the issuance of additional stored water agreements for M&I use that may be associated with this measure is necessary to ensure that all parties engaged with in-season management can have trust and confidence that OWRD has adequate means in place to enforce secondary permits that will arise from issuance of additional water storage agreements by the Corps. This continuing partnership between the Corps and OWRD will help to ensure that the Corps continues to exercise its discretion to store and release water for authorized project purposes in ways that are consistent with the purposes of the ESA, and that the OWRD can fulfill its mission to promote Oregon's water supply needs while protecting and restoring streamflow as needed for the long-term sustainability of Oregon's ecosystems, economy, and quality of life.

RPA Measure 3 ensures that increased diversions resulting from the proposed action would be reduced in years of stored water shortage, and that new water contracts would not be issued for out of stream uses in tributaries where sufficient water is not available. These restrictions limit reductions in instream flow such that resulting changes in water quality and habitat availability would not appreciably reduce the abundance or productivity of UWR Chinook salmon or steelhead. RPA Measure 3 also ensures that increased diversions that occur in the mainstem Willamette River below Salem will be offset by additional stored water releases, and that water temperatures in the mainstem will not exceed levels that would unacceptably reduce the productivity of UWR Chinook salmon. RPA Measure 3 is reasonable and prudent because it allows the Corps to proceed with issuing new agreements to M&I stored users in a manner that makes them consistent with existing constraints on water storage contracts for irrigated agriculture that were determined necessary to avoid jeopardizing UWR species in NMFS (2008a).

RPA Measure 4 increases the likelihood adaptive management of the WBR allocations will result in NMFS (2008a) minimum flow objectives being met in years the WVS reservoirs do not fill over the management strategy put forward in the Proposed Action. This measure avoids the majority of effects the Proposed Action would otherwise have on instream flows by retaining sufficient stored water for ESA-listed fish needs, and therefore ensures that reductions in instream flow as a result of the water marketing program would not reach the level where increased water temperatures and reduced habitat availability or appreciably reduce the abundance or productivity of UWR Chinook salmon or steelhead. RPA Measure 4 is reasonable and prudent because it will continue to allow the Corps' to provide adaptive management of stored water to meet other project purposes, while still meeting its legal obligation to comply

with minimum flow objectives necessary for the survival and recovery of ESA-listed salmon and steelhead. This measure is necessary to ensure proportional reduction will not limit the Corps' ability to operate the project to deliver water as needed to meet minimum tributary and mainstem flow objectives (NMFS 2008a). When the Corps forecasts that the minimum flow objectives will not be met, they will also curtail new M&I and AI allocations to limit the risk that reduced storage volume remain to meet minimum flow objectives necessary for the survival and recovery of ESA-listed salmon and steelhead later in the conservation season.

RPA Measure 5 addresses the uncertainty around existing regulatory mechanisms and efficacy of instream water rights enforcement by documenting whether the outcomes of this program are consistent with NMFS' assumptions about the performance of the RPA. This reporting also reduces the likelihood that minimum instream flow objectives will be missed in subsequent years as issues will be identified and can be resolved after each annual reporting cycle. RPA Measure 5 therefore is expected to further reduce impacts of the water contracting program on instream flows necessary for ESA-listed fish to the extent that changes in water temperature and habitat availability do not appreciably reduce the abundance or productivity of UWR Chinook salmon or steelhead. This Measure is reasonable and prudent because the performance of the Annual Conservation Plan will allow NMFS to assess whether the proposed action is causing effects consistent with the effects analyzed in this opinion, and provide transparency necessary for all parties to have trust and confidence in the fair administration of the water management process. This monitoring is also reasonable because it could easily be incorporated in monitoring and synthesis that is currently reported annually by the Corps in "Willamette Basin Year in Review" reports.

RPA Measures 1 through 5 together avoid jeopardy despite the likelihood of potential future climate change effects because they provide the flexibility to adapt in-season management of the WVS to the likelihood and scale of expected climate change while still meeting the flow and temperature needs of UWR Chinook salmon and steelhead. Recovery of the species hinges further on other actions, particularly that the Corps and other parties make the expected progress towards providing or improving fish passage of juvenile fish at multiple dams, rehabilitation of degraded habitat throughout the Willamette Basin, reform of fish hatchery practices, and other sound recovery actions continue as planned and funded. However, the effects of the proposed action will not significantly delay or preclude recovery if implemented according to this RPA.

Under this RPA, the volume of water available to new contracts and associated new or increased diversions prior to protection of instream flows for fish and wildlife will be small enough that resulting changes in mainstem Willamette River flows only have the potential to increase temperatures downstream of Salem by less than 0.2 degrees C (USACE 2019d). Following the protection of instream flows for fish and wildlife the contracting of full M&I and AI allocations is likely to cause additional flow reductions in the tributaries and mainstem Willamette River, however, the RPA measures governing adaptive management will almost entirely preclude or offset these effects to the extent that they will not jeopardize either UWR Chinook salmon or steelhead, or adversely modify their critical habitats. The effects of the proposed action that are not fully precluded or offset by this RPA are described in the Incidental Take Statement (Section 2.10).

Because this biological opinion has found jeopardy and destruction or adverse modification of critical habitat, Corps is required to notify NMFS of its final decision on the implementation of the RPA.

2.10 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. “Take” is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. “Harm” is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). “Incidental take” is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

2.10.1 Amount or Extent of Take

Operation of the WVS causes ongoing incidental take of UWR Chinook salmon and UWR steelhead. The amount and extent of incidental take caused by the WVS is identified in our 2008 biological opinion on WVS operations (NMFS 2008a). The WBR will cause an additional, discrete amount of incidental take that is in addition to the incidental take caused by operation of the WVS. This section identifies only incidental take that can be attributed to the WBR. That take is due to effects of water contracting under the RPA, which will occur as: 1) reduced availability and quality of spawning, holding, and rearing habitat between points of diversion and the confluence of the tributaries or downstream dams; and 2) reduced availability and quality of rearing and migration habitat in the mainstem Willamette River.

In the biological opinion, NMFS determined that incidental take will occur as follows:

As a result of the Corps’ current operation of the Willamette Project dams and reservoirs to administer the BOR’s water contract program under the proposed allocation, diversions cause take of UWR Chinook salmon and UWR steelhead in the action area. In addition, administering the proposed M&I water contract program will cause additional take of UWR Chinook salmon and UWR steelhead in the action area, beyond the take included in the baseline relating to dam operations. Because of the inherent biological complexity of listed salmon and steelhead, and the dimensions and variability of the river system, it is not possible to quantify the extent of take through this pathway for juveniles and adults killed or injured by implementation of the RPA.

The distribution and abundance of fish that occur within the action area are affected by habitat quality, competition, predation, and the interaction of processes that influence genetic, population, and environmental characteristics. These biotic and environmental processes interact in ways that may be random or directional, and may operate across far broader temporal and

spatial scales than are affected by the proposed action. Thus, where take occurs due to actions that change the distribution and abundance of fish within the action area, those changes cannot be attributed entirely to habitat conditions, nor can NMFS precisely predict the number of fish that are reasonably certain to be taken (harmed, injured or killed) if their habitat is modified or degraded by the proposed action. In such circumstances, NMFS cannot quantify the amount of take that would be caused by the proposed action.

Therefore, NMFS will employ a surrogate measure of take in the form of the geographic extent of the temporal extent of reduced flows in river reaches where that reduction is likely to cause harm to UWR Chinook and/or steelhead. These temporal and geographic descriptions of the extent of take are described below in Tables 2.10-1 and 2.10-2.

Note that the tables include some varying levels of take depending on whether protections for instream flows are in place. RPA Measure 2 will lead to the development of protection for instream flows. This protection will be reviewed with NMFS prior to expansions in either M&I or AI contracts for stored water beyond what is specified in RPA Measure 2. After NMFS issues its written agreement to the Corps and the OWRD that the necessary plan with institutional mechanisms and infrastructure support for instream flow protection is complete, implementation of the agreed upon protections will allow for the proposed allocation. In addition, RPA Measures 3 through 5 must be implemented to manage delivery of flows due to the re-allocation, or curtailments as needed. Given full RPA implementation¹⁶, the total take will be limited over the duration of the proposed action to that shown in Tables 2.10-1 and 2.10-2.

Take of individuals of the other 11 species (LCR steelhead, LCR Chinook Salmon, LCR coho Salmon, CR chum salmon, MCR steelhead, SR steelhead, SR fall Chinook salmon, SR spring/summer Chinook salmon, SR sockeye salmon, UCR steelhead, and UCR spring Chinook salmon) would be limited to those that occurred due to adverse effects on habitat conditions in the lower Columbia River and estuary (e.g., altered flows, reduced water quality), but these were determined to be slight to negligible.

The best available surrogate measures of the extent of take are:

- (1) For harm associated with implementing the water contracting program, prior to protection of instream flows for F&W (per RPA 2): the percent of days existing NMFS (2008a) minimum flow objectives will not be met during key months UWR species are in the mainstem Willamette River below Salem. Tributary flows should not be affected by the smaller amount of contracts under the limit in RPA 2, given the distribution proposed with 71% in the mainstem (BA Figure ES-2, USACE 2018a).
- (2) For harm associated with implementing the water contracting program after instream flows have been protected for F&W (per RPA 2): the percent of days existing NMFS (2008a) minimum flow objectives, along with additional stored water releases to

¹⁶ RPA Measure 2 will lead to the development of protection for instream flows. This protection will be reviewed with NMFS prior to expansions in either M&I or AI contracts for stored water beyond what is specified in RPA Measure 2. After NMFS issues its written agreement to the Corps and the OWRD that the necessary plan with institutional mechanisms and infrastructure support for instream flow protection is complete, implementation of the agreed upon protections will allow for the proposed allocation. In addition, RPA Measures 3 through 5 must be implemented to manage delivery of flows due to the re-allocation, or curtailments as needed.

offset new diversions, will not be met during key months UWR species are in tributary and mainstem reaches in the Willamette Basin.

Specifically, the anticipated take will be exceeded if the number of days minimum flow objectives from NMFS (2008a) are missed exceed the values given in Tables 2.10-1 and 2.10-2. This take indicator operates as an effective reinitiation trigger because the Corps has the ability to monitor minimum flow objective performance with real-time data from existing USGS gages in the Willamette River Basin, and has the authority to curtail and adaptively manage releases of stored water to meet ESA requirements, as described in the RPA, to address noncompliance (33 CFR 326.4).

These surrogate measures are logically related to the extent of incidental take expected to occur. These features best integrate the likely take pathways associated with this action, are proportional to the anticipated amount of take, and are the most practical and feasible indicators to measure. In particular, the percentage of days that flow targets are missed during key months is directly correlated to the potential for harm due to reductions in available habitat and, during specific times of year, the potential for harm due to increases in water temperature. Additionally, these surrogate measures can be meaningfully observed and monitored to determine when they have been exceeded, using USGS gage data and the Corps reservoir management data (including the Willamette teacup, CITE <http://www.nwd-wc.usace.army.mil/nwp/teacup/willamette/>).

Table 2.10-1 Estimates of the type and geographic and temporal extent of incidental take of UWR Chinook salmon associated with effects of the Willamette Basin Review

FEATURE	LIFE STAGE	TYPE OF TAKE	GEOGRAPHIC LOCATION OF TAKE*	TEMPORAL EXTENT OF TAKE¹⁷
Tributaries: Water contract administration following protection of instream flows for F&W per RPA 2	Adults	Reduced spawning habitat quality and reduced amount of adult holding habitat	North Santiam, South Santiam, and mainstem Santiam Rivers (Reaches 2-4, sums to 10.3% of projected total demand); from storage contract points of diversion to confluence with Willamette River.	Percent of days mean daily discharge does not exceed minimum objectives due to insufficient stored water releases to offset new diversions. May-August – 3% September – 5%
Tributaries: Water contract administration following protection of instream flows for F&W per RPA 2	Adults	Reduced spawning habitat quality and reduced amount of adult holding habitat	McKenzie River (Reach 8, 2.1% projected total demand); Corps dams (Blue River and Cougar), and Middle Fork Willamette River (Reach 11, 4.1% projected total demand); from storage contract points of diversion to confluence with downstream dams or Willamette River.	Percent of days mean daily discharge does not exceed minimum objectives due to insufficient stored water releases to offset new diversions. May-August – 3% September – 5%
Tributaries: Water contract administration following protection of instream flows for F&W per RPA 2	Juveniles	Reduced rearing habitat quality; barrier to shallow juvenile rearing habitat, stranding	All reaches in tributaries where the Corps does not release amount equal to sum of new contracts; from storage contract points of diversion to confluence with Willamette River	Percent of days mean daily discharge does not exceed minimum objectives due to insufficient stored water releases to offset new diversions. May-August – 3% September – 5%
Mainstem flows: Water contract administration	Adults	Reduced migration habitat quality, reduced amount of adult holding habitat	Mainstem reaches diversions below Salem (Reach 1, ~71% of projected total demand); from storage contract point of diversion to Willamette Falls	Percent of days mean daily discharge does not exceed minimum objectives, due to insufficient stored water releases to offset new diversions, unless coordinated through the WATER flow management committee process May-September –4%
Mainstem flows: Water contract administration	Juveniles	Reduced rearing habitat quality; stranding	Mainstem reaches diversions below Salem (Reach 1, ~71% of projected total demand); from storage contract point of diversion to Willamette Falls	Percent of days mean daily discharge does not exceed minimum objectives due to insufficient stored water releases to offset new diversions unless coordinated through the WATER flow management committee process May-September –4%
Mainstem flows: Water contract administration following protection of	Adults	Reduced migration habitat quality, reduced amount of adult holding habitat	Mainstem reaches with diversions above Salem, (Reaches 5, 7, 9, sum to 7.4% of projected total demand), and reaches with diversions below Salem	Percent of days mean daily discharge does not exceed minimum objectives due to insufficient stored water

¹⁷ Minimum flow objectives are based on timing by periods specified in the 2008 Biological Opinion, or any biological opinion that may be issued as the result of a future ESA consultation related to the storage and release of stored water from the WVS.

FEATURE	LIFE STAGE	TYPE OF TAKE	GEOGRAPHIC LOCATION OF TAKE*	TEMPORAL EXTENT OF TAKE¹⁷
instream flows for F&W per RPA 2			(Reach 1, ~71% of projected total demand); from storage contract point of diversion to Willamette Falls	releases to offset new diversions unless coordinated through the WATER flow management committee process May-September –3%
Mainstem flows: Water contract administration following protection of instream flows for F&W per RPA 2	Juveniles	Reduced rearing habitat quality; stranding	Same as above	Percent of days mean daily discharge does not exceed minimum objectives due to insufficient stored water releases to offset new diversions, unless coordinated through the WATER flow management committee process May-July –3%

*Reaches from USACE (2018a) Map ES-2

Table 2.10-2 Estimates of the type and geographic and temporal extent of incidental take of UWR steelhead associated with effects of the Willamette Basin Review

FEATURE	LIFE STAGE	TYPE OF TAKE	GEOGRAPHIC LOCATION OF TAKE*	TEMPORAL EXTENT OF TAKE¹⁸
Tributaries: Water contract administration following protection of instream flows for F&W per RPA 2	Adults	Reduced spawning habitat quality and reduced amount of adult holding habitat.	North Santiam, South Santiam, and mainstem Santiam Rivers (Reaches 2-4, 10.3% of projected total demand); from storage contract points of diversion to confluence with Willamette River	Percent of days mean daily discharge does not exceed minimum objectives due to insufficient stored water releases to offset new diversions. April-June -3%
Tributaries: Water contract administration following protection of instream flows for F&W per RPA 2	Juveniles	Reduced rearing habitat quality; barrier to shallow juvenile rearing habitat, stranding, and possible emergence timing changes	Santiam Rivers if the Corps does not release amount equal to sum of new contracts, from storage contract points of diversion to confluence with Willamette River	Percent of days mean daily discharge does not exceed minimum objectives due to insufficient stored water releases to offset new diversions. June-September – 5%
Mainstem flows: Water contract administration	Juveniles	Reduced rearing and outmigrating habitat	Mainstem reaches with diversions below Salem (Reach 1, ~71% of projected total demand); from storage contract point of diversion to Willamette Falls	Percent of days mean daily discharge does not exceed minimum objectives due to insufficient stored water releases to offset new diversions, unless coordinated through the WATER flow management committee process. April-June -4%
Mainstem flows: Water contract administration following protection of instream flows for F&W per RPA 2	Juveniles	Reduced rearing and outmigrating habitat	Mainstem reaches with diversions below Salem (Reach 1, ~71% of projected total demand); from storage contract point of diversion to Willamette Falls	Percent of days mean daily discharge does not exceed minimum objectives ¹⁹ due to insufficient stored water releases to offset new diversions, unless coordinated through the WATER flow management committee process. April-June -3%

*Reaches from USACE (2018a) Map ES-2

¹⁸ Minimum flow objectives are based on timing by periods specified in the 2008 Biological Opinion, or any biological opinion that may be issued as the result of a future ESA consultation related to the storage and release of stored water from the WVS.

¹⁹ Based on timing of missed dates following the 2008 Biological Opinion.

2.10.2 Effect of the Take

In the biological opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat when the reasonable and prudent alternative is implemented.

2.10.3 Reasonable and Prudent Measures

“Reasonable and prudent measures” are nondiscretionary measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02).

The Corps must comply with all of the following reasonable and prudent measures and related terms and conditions, which are non-discretionary.

1. Provide documentation of the RPA Measures 3.1-3.5 steps which have been applied to all new water use contracts, prior to finalizing the contract.
2. Use in-season information regarding anticipated live flow, storage contracts timing, and gaging or other meters at locations above and below diversions, to provide updates during the delivery season of possible missed minimum flow objectives.
3. Ensure completion of a monitoring and reporting program to demonstrate compliance with the requirements of this ITS. The report will include recommendations, if any, to modify project operations to further improve water availability for instream flow targets and instream flow water rights.

2.10.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and the Corps or any applicant must comply with them in order to implement the RPMs (50 CFR 402.14). The Corps or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse. These terms and conditions constitute no more than minor changes because they only provide further elaboration on the more general measures in the PA and RPA. These terms and conditions are non-discretionary. NMFS may amend the provisions of this ITS consistent with its statutory and regulatory authorities. Timely reporting of the results from Monitoring and Evaluation activities will help to identify the potential need to take such corrective action.

1. To implement reasonable and prudent measure #2, the Corps will:
 - a. In April of each year, project the potential for filling each reservoir used for downstream flow targets in the 2008 RPA (Tables 9.2-1 and 9.2-2, and Appendix D, Table D-4 if appropriate) from available data on snow pack and expected precipitation and live stream flow.

- b. Notify contract holders of the expected fill levels and any limits to storage volumes for their use by late April, with updates by May 31.
- 2. To implement reasonable and prudent measure #2, the Corps will:
 - a. For each contract, determine gage instruments at or nearby which will allow OWRD to enforce restrictions based on RPA Measures 3 and 4, before the 2nd year following new contract agreements.
 - b. Notify FMWQT one week prior to contract holder curtailment or cutoffs in any reach.
- 3. To implement reasonable and prudent measure #3, the Corps will:
 - a. Provide the review and reports (Annual Conservation Plan, Willamette Basin Year in Review Report) described in detail in RPA Measure 5.
 - b. Schedule an annual coordination meeting by March 1st of each year with NMFS, to discuss prior year(s)' efforts to comply with all RPA measures.
 - c. Finalize draft reports for in-season use by June 1, and for previous year's performance by June 30.

2.11 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02).

NMFS recommends the Corps take the following actions:

- 1. Consider lamprey protection and conservation efforts when evaluating F&W instream flow needs in the basin, and include Tribes as participants in ongoing and future water management coordination, studies related to water management, water quality, ESA-listed species, or lamprey in the Willamette Basin, and any other measures related to operation of the WVS.
- 2. Work with each municipal or industrial entity with which it enters into a storage agreement to develop or modify that entity's Water Conservation Plan to set higher water conservation and efficiency goals and improve water conservation measures and strategies.
- 3. Encourage BOR to similarly work with agricultural irrigation contract holders to develop plans to improve water conservation measures which increase efficiency and reduce loss of diverted water in conveyance and irrigation.

These recommended actions would address water quality, contaminants, and habitat degradation, which are factors limiting the recovery of ESA-listed fish species in the action area. Taking such actions in the Willamette Basin could further support the recovery of at-risk species.

2.12 Reinitiation of Consultation

This concludes formal consultation for Willamette Basin Review Feasibility Study.

As 50 CFR 402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) The amount or extent of incidental taking specified in the ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect on the listed species or critical habitat that was not considered in this opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

2.13 “Not Likely to Adversely Affect” Determinations

2.13.1 Southern Resident Killer Whale

The Southern Resident killer whale DPS was listed as endangered on February 16, 2006 (70 FR 69903) and a recovery plan was completed in 2008 (NMFS 2008b). A 5-year review under the ESA completed in 2016 concluded that Southern Residents should remain listed as endangered and includes recent information on the population, threats, and new research results and publications (NMFS 2016b). Because NMFS determined the action is not likely to adversely affect SKRWs or their critical habitat, this document does not provide detailed discussion of environmental baseline or cumulative effects for the SRKW portion of the action area.

Several factors identified in the final recovery plan for Southern Resident killer whales may be limiting recovery including quantity and quality of prey, toxic chemicals that accumulate in top predators, and disturbance from sound and vessels. It is likely that multiple threats are acting together to impact the whales. Although it is not clear which threat or threats are most significant to the survival and recovery of Southern Residents, all of the threats identified are potential limiting factors in their population dynamics (NMFS 2008b).

Southern Resident killer whales consist of three pods (J, K, and L) and inhabit coastal waters off Washington, Oregon, and Vancouver Island and are known to travel as far south as central California and as far north as Southeast Alaska (NMFS 2008b; Hanson et al. 2013; Carretta et al. 2017). During the spring, summer, and fall months, the whales spend a substantial amount of time in the inland waterways of the Strait of Georgia, Strait of Juan de Fuca, and Puget Sound (Bigg 1982; Ford 2000; Krahn et al. 2002; Hauser et al. 2007; Hanson and Emmons 2010). By late fall, all three pods are seen less frequently in inland waters. In recent years, several sightings and acoustic detections of Southern Residents have been obtained off the Washington and Oregon coasts in the winter and spring (Hanson et al. 2010; Hanson et al. 2013, NWFSC unpubl. data). Satellite-linked tag deployments have also provided more data on the Southern Resident killer whale movements in the winter indicating that K and L pods use the coastal waters along Washington, Oregon, and California during non-summer months.

Southern Resident killer whales consume a variety of fish species (22 species) and one species of squid (Ford et al. 1998; Ford 2000; Ford and Ellis 2006; Hanson et al. 2010; Ford et al. 2016), but salmon are identified as their primary prey. Southern Residents are the subject of ongoing research, including direct observation, scale and tissue sampling of prey remains, and fecal sampling. Scale and tissue sampling from May to September indicate that their diet consists of a high percentage of Chinook salmon (monthly proportions as high as >90%) (Hanson et al. 2010; Ford et al. 2016). Recently, Ford et al. (2016) confirmed the importance of Chinook salmon to the Southern Residents in the summer months using DNA sequencing from whale feces. Salmon and steelhead made up to 98% of the inferred diet, of which almost 80% were Chinook salmon. Coho salmon and steelhead are also found in the diet in spring and fall months when Chinook salmon are less abundant (Ford et al. 1998; Ford and Ellis 2006; Hanson et al. 2010; Ford et al. 2016). Prey remains and fecal samples collected in inland waters during October through December indicate Chinook salmon and chum salmon are primarily contributors of the whale's diet (NWFSC unpubl. data).

Observations of whales overlapping with salmon runs (Wiles 2004; Zamon et al. 2007; Krahn et al. 2009) and collection of prey and fecal samples have also occurred in the winter months. Preliminary analysis of prey remains and fecal samples sampled during the winter and spring in coastal waters indicated the majority of prey samples were Chinook salmon (80% of prey remains and 67% of fecal samples were Chinook salmon), with a smaller number of steelhead, chum salmon, and halibut (NWFSC unpubl. data). The occurrence of K and L pods off the Columbia River in March suggests the importance of Columbia River spring runs of Chinook salmon in their diet (Hanson et al. 2013). Chinook salmon genetic stock identification from samples collected in winter and spring in coastal waters included 12 U.S. west coast stocks, and over half the Chinook salmon consumed originated in the Columbia River (NWFSC unpubl. data).

As of July 2017, Southern Residents totaled 77 individuals (24 in J pod, 18 in K pod, and 35 in L pod). Since the July census, an additional member died and the current population totals 76 individuals. The NWFSC continues to evaluate changes in fecundity and mortality rates, and has updated the work on population viability analyses conducted for the 2004 Status Review for Southern Resident Killer Whales and a science panel review of the effects of salmon fisheries (Krahn et al. 2004; Hilborn et al. 2012; Ward et al. 2013). Following from that work, the data now suggests a downward trend in population growth projected over the next 50 years. As the model projects out over a longer time frame (50 years) there is increased uncertainty around the estimates, however, if all of the parameters in the model remain the same the overall trend shows a decline in later years. To explore potential demographic projections, Lacy et al. (2017) constructed a population viability assessment that considered sublethal effects and the cumulative impacts of threats (contaminants, acoustic disturbance, and prey abundance). They found that over the range of scenarios tested, the effects of prey abundance on fecundity and survival had the largest impact on the population growth rate (Lacy et al. 2017).

The proposed action may affect Southern Resident killer whales and their critical habitat through indirect effects to their primary prey. This analysis focuses on effects to Chinook salmon availability in the ocean because the best available information indicates that salmon are the preferred prey of Southern Resident killer whales year round, including in coastal waters, and

that Chinook salmon are the preferred salmon prey species. To assess the indirect effects of the proposed action on the Southern Resident killer whale DPS, we considered the geographic area of overlap in the marine distribution of Chinook salmon affected by the action, and the range of Southern Resident killer whales. We also considered the importance of the UWR Chinook salmon compared to other Chinook salmon runs in Southern Resident diet composition, and the influence of hatchery mitigation programs in the Willamette Basin.

The primary effect pathway by which the proposed action would harm UWR Chinook salmon is by reducing instream flow and increasing water temperatures in the mainstem Willamette River and its major east-side tributaries. As described in the Effects Section, adult UWR Chinook salmon migrating through and holding in the mainstem Willamette River and spawning in the tributaries may be exposed to higher temperatures as a result of the proposed action, and that increased thermal stress is likely to increase pre-spawning mortality. Increased pre-spawning mortality of UWR Chinook salmon is not expected to appreciably impact Southern Resident killer whales because:

1. UWR Chinook are not among the highest priority prey stocks for Southern Residents.

UWR Chinook salmon are not among the ten highest priority Chinook salmon prey stocks for Southern Resident killer whales. While they have a high potential to overlap in space and time with Southern Residents they have not been observed in the diet based on opportunistic sampling (NMFS and WDFW 2018). Other Columbia Basin stocks that are higher priority as Southern Resident prey include the LCR, MCR, UCR, and Snake fall Chinook salmon, LCR, MCR, and UCR spring-run Chinook salmon, MCR and UCR summer Chinook salmon and Snake Spring-Summer Chinook salmon. Several of these Columbia Basin stocks are on steady or recovering population trajectories. These increasing abundance trends and relative abundance of these stocks compared to UWR Chinook salmon would likely mean reduced UWR adult abundance due to the proposed action would be proportionally small and a negligible decrease in available prey.

2. Changes in the abundance of UWR Chinook salmon caused by the proposed action would not be detectable in the areas where they would be available as prey to Southern Resident Killer Whales because of the ongoing UWR Chinook salmon hatchery program.

Although there would be reductions in the abundance and productivity of natural-origin Chinook salmon, we do not anticipate this would affect the overall net prey availability for Southern Resident killer whales. Ongoing hatchery programs associated with operation of the WVS will continue to supplement productivity of naturally spawning UWR Chinook salmon with production and release of juveniles to meet minimum adult return abundance targets established for each of the four major east-side tributaries in the Willamette Valley until the wild spawning populations are self-sustaining and meeting reintroduction and recovery goals (ODFW and USACE 2016a-c, USACE and ODFW 2018, NMFS 2019). Reductions in productivity of naturally spawning UWR Chinook salmon caused by the proposed action are therefore not likely to result in a detectable change in the total abundance of adult UWR Chinook salmon (natural and hatchery origin) available as prey to Southern Resident killer whales on their feeding grounds.

In addition, any premature adult Chinook salmon mortalities related to increased thermal stress caused by the proposed action would occur after the fish have returned to the river and are no longer available to the whales in the ocean. Changes in abundance of UWR that affect adult life stages would therefore also not decrease the availability of prey for Southern Resident killer whales.

In summary, ongoing hatchery production of UWR Chinook salmon together with the abundance of other key prey Chinook salmon stocks in the action area (which are not likely to be adversely affected by the proposed action) make it impossible to meaningfully measure a change in Southern Resident killer whale prey availability due to the proposed action. In addition, pathways do not exist for potential increases in contaminants from the proposed action to contribute detectable increases in organic pollutants in the killer whale diet. NMFS concludes that the potential effects of the proposed action to Southern Resident killer whales and their critical habitat are insignificant. Therefore, we conclude that the proposed action is not likely to adversely affect Southern Resident killer whales.

3. MAGNUSON-STEVEN FISHERY CONSERVATION AND MANGEMENT ACT ESSENTIAL FISH HABITAT CONSULTATION

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. The MSA (section 3) defines EFH as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.” Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

This analysis is based, in part, on the Biological Assessment for ESA consultation provided by the Corps and descriptions of EFH for Pacific Coast salmon (PFMC 2014) contained in the fishery management plans developed by the PFMC and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

As part of the information provided in the request for ESA consultation, NMFS determined that the proposed action was likely to adversely affect EFH designated for Chinook and coho salmon as identified in the Fishery Management Plan for Pacific coast salmon (PFMC 2014). The effects of the proposed action on EFH are the same as those described above in the ESA portion of this document, and NMFS finds that effects to EFH would be consistent with effects to critical habitat (Section 2.5.2).

3.2 Adverse Effects on Essential Fish Habitat

Based on information provided by the action agency and the analysis of effects presented in the ESA portion of this document, NMFS concludes that proposed action will have adverse effects on EFH designated for Chinook and coho salmon. These effects include changes in water quantity associated with changes in flow releases and timing, and degradation of water quality from increased temperatures due to additional municipal, industrial, and agricultural diversions.

3.3 Essential Fish Habitat Conservation Recommendations

RPA measures one through five and additional conservation recommendations one through three identified in the ESA portion of this document are adopted as EFH conservation recommendations to address the effects also identified in that section.

Fully implementing these EFH conservation recommendations would protect, by avoiding or minimizing the adverse effects described in Section 2.5, above, designated EFH for Pacific Coast salmon.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the Corps must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations unless NMFS and the Federal agency have agreed to use alternative time frames for the Federal agency response. The response must include a description of measures proposed by the agency for avoiding, minimizing, mitigating, or otherwise offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the Conservation Recommendations, the Federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)).

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we ask that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

3.5 Supplemental Consultation

The Corps must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations (50 CFR 600.920(l)).

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the Corps. Other interested users could include the OWRD, BOR, ODFW, Tribes, State and Federal resource managers, current or future holders of stored water contracts in the Willamette Basin, citizens of affected areas, and others interested in the conservation of the affected ESU and DPS. Individual copies of this opinion were provided to the Corps. The format and naming adheres to conventional standards for style.

4.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3 Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion and EFH consultation contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA and MSA implementation, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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